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THE EXTERNAL MORPHOLOGY OF CHRYSOPA PERLA L. (NEUROPTERA: CHRYSOPIDÆ)*

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INTRODUCTION

The purpose of this thesis is to make a complete morphological study of a typical chrysopid with the hope of finding morphological characters which may be used as a basis for future systematic work on the group. Color and wing venation have been largely used in the group for specific differences, but many present taxonomists find that body morphological characters are of more value for systematic work.

The Palearctic *Chrysopa perla* L. was selected for two reasons; first, it is typical of the family and, second, the sutures demarking the sclerites are more distinct than in any of the native species.

Dr. G. C. Crampton furnished the material which he collected in Norway. The writer was also very fortunate in securing from Staudinger and Bang-Haas, Germany, eight specimens of *Chrysopa perla*, three of which were determined by L. Navás.

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HISTORY

Linnaeus (1758) described *Hemerobius perla* as "*H. viridis*, alis hyalinis: vasis viridibus." Leach (1815) made a new genus *Chrysopa* in which he placed *H. perla* and put this genus in a new family Hemerobida. Westwood (1840) designated *perla* as the genotype of *Chrysopa*. Schneider (1851) divided Hemerobidæ into three divisions and placed *Chrysopa* in Chrysopina. Hagen (1866) made Chrysopidæ a subfamily of Hemerobidæ and in so doing made *Chrysopa* the type genus. MacLachlan (1868) raised Chrysopidæ to the rank of family. The various stages in our knowledge of this subject may be shown by the accompanying table.

Linnaeus 1758	Phryganea Hemerobius perla	Hemerobius perla described
Leach 1815	Hemerobida Chrysopa perla	Chrysopa became a genus
Westwood 1840	Hemerobiidæ Chrysopa perla	Chrysopa perla became the genotype
Schneider 1851	Hemerobidæ Chrysopina Chrysopa perla	Chrysopina designated as a division
Hagen 1866	Hemerobidæ Chrysopidæ Chrysopa perla	Chrysopidæ designated as a subfamily; Chrysopa became the type genus
MacLachlan 1868	Hemerobiina Chrysopidæ Chrysopa perla	Chrysopidæ raised to family rank

The chief workers on the group are: Banks (1909), Brauer (1850), Hagen (1861, 1866), MacLachlan (1868), McDunnough, (1909), Navás (1925), Pariser (1919), Petersen (1927), Pongrácz (1919), Schneider (1851), Smith (1922), Stitz (1927?), Tichomirowa (1892), Tillyard (1916) and Withycombe (1922).

DISTRIBUTION

Chrysopa perla has a wide range in Eurasia, being found in Great Britain, throughout continental Europe as far north as Scandinavia and Finland and south to Hungary, and in central Siberia.

GENERAL APPEARANCE

Chrysopa perla as compared with other members of the family is of medium size. There is, however, noticeable variation of size within the species. In general its color is blue green. The longitudinal veins of the wings are green while the greater number of the cross-veins are dark brown. The head is yellowish-green with a dark brown spot on the gena and each side of the clypeus. Between the antennæ is an X-shaped marking which is continued on top of the head as a forked band, the arms of which meet a transverse band at the back of the head. The antennæ which are shorter than the wings are a pale reddish-brown; the basal segment is yellowish-green with brown at the proximal end; the second segment is dark brown with light brown edges. The thorax is green, with two dark brown spots on each side of the prothorax and dark symmetrical spots on the meso- and metathorax. The legs are green. The pleurites of the abdomen are dark green, while the tergites and sternites are dark brown with green edges.

EXTERNAL MORPHOLOGY

Head and its Appendages

The head, from the frontal aspect, is somewhat circular in out line, arching slightly at the vertex. There are no sexual characters on the head. Most of the sutures which in many insects demark the various sclerites of the head capsule are absent in *Chrysopa perla.* Thus as the sclerites are not distinctly sepa-

rated, the names in most cases apply merely to areas in general rather than to clearly defined parts.

Head capsule (Pl. I, Figs. 4, 8) : The areas making up the head capsule are the occiput, vertex, frons, genæ, postgenæ, gula, clypeus, and labrum.

The *occiput* (ocp) is the caudal portion of the head dorsad of the *occipital foramen* (for). The occipital foramen is the posterior opening in the head capsule through which the alimentary canal, nervous system and other organs pass back into the thorax.

The *frons* (fr) and *vertex* (v) occupy the dorsal area of the head. The vertex is slightly arched dorsally and, from a frontal aspect, appears as a large median lobe, with a smaller one on each side which extends to the dorsal margin of the eyes. The *temporal sutures* (ts) extend forward from the *occipital suture* (os) and demark the temporal regions. The epicranial suture present in many insects demarking the frons and vertex is lacking, thus causing these regions to appear as one area. The frons is bounded laterally by the *frontal sutures* (fsu) and anteriorly by the *epistomal suture* (esu).

The *frontal pits* (frp) lie in the anterior portion of the frontal sutures. They are clearly defined depressions which externally mark the internal invaginations of the body wall forming the anterior arms of the tentorium.

The *compound eyes* (e) which are large, semi-spherical and many faceted are dorso-lateral in position. They are a beautiful golden color in life, and very iridescent. There are two *antennifers* (anf) in each antennal socket. These are heavily sclerotized projections from the inner and outer ventro-lateral margins of the antennal sockets.

The *antennæ* (Pl. I, Fig. 3) are long, delicate, filiform appendages and are approximately three-fourths as long as the fore wings. They vary greatly as to the number of segments composing them. The first segment, or *scape* (scp), is flattened and much broader and longer than the other segments. The basal end is the broader and is colored dark brown. The second segment, or *pedicle* (pd), is dark brown in the central portion. It is slightly shorter than the scape, cylindrical and slightly con-

stricted in the middle. The remaining segments form the *flagellum* (fl) and are encircled by four rows of setæ. The third segment is not so broad or so long as the pedicle. The fourth segment is the shortest. The fifth and succeeding segments are subequal and are longer than the fourth, but are shorter than the third. The distal segments taper very slightly, the last being pointed at the apex.

The *genæ* (ge), or cheeks, are the anterior portions of the latero-cephalic regions just behind and below the compound eyes. The frontal sutures demark the frons from the genæ. The genæ are bounded anteriorly by the *subgenal sutures* (sgs). Postero-laterally they merge into the *postgenæ* (pge) since no suture separates the two. The postgenal region is the cephalo-ventral surface of the head capsule on each side of the foramen.

The *gula* (gu) (Pl. II, Fig. 10) is a sclerite in the postero-ventral portion of the head capsule and does not form a part of the skull. It is a narrow transverse plate with anteriorly directed arms, bearing the labium at its cephalic end.

The *gular pits* (gup) are located at the postero-lateral edges of the gula. These pits are external depressions marking the positions of the posterior arms of the tentorium.

The *clypeus* (cl) occupies about one-third of the frontal portion of the head capsule and extends from the *labrum* (lr) posteriorly to the epistomal suture. This suture is well marked and extends between the anterior ends of the frontal sutures, arching slightly in the middle. The latero-distal angles of the clypeus are rounded. Just above and parallel with the distal margin is a row of slight depressions, each containing a seta.

The *labrum* (lr) is a narrow, transverse sclerite with its apical margin arcuately concave, and its latero-distal angles are broadly rounded.

Tentorium (Pl. I, Figs. 7, 8) :—This is very well marked as a heavily sclerotized internal skeleton of the head. It is composed of the *body of the tentorium* (tnt), and three pairs of arms, namely, the *anterior arms* (at), the *posterior arms* (pt), and the *dorsal arms* (dt). Fig. 7 is a mesal view of the endoskeleton along its median axis and shows only one half of it.

One end of each anterior arm leads forward to the frontal pit; the other extends in a caudo-mesal direction, expanding along its mesal margin, then narrows for a distance and extends farther caudad until it finally fuses with the corresponding end of the other arm, forming a bridge (tnt) at its caudal extremity. From this bridge, or body of the tentorium, the two posterior arms extend laterally and posteriorly, leading back to the gular pits.

The dorsal arms are sclerotized, thread-like structures arising from the lateral margins of the anterior arms. They extend upward and become attached to the dorsal wall of the head capsule in the region of the antennæ.

Mandibles (md) (Pl. I, Fig. 4; Pl. II, Figs. 11, 12):—These are well developed and fitted for crushing. They are pyramidal with three faces. The outer face, appearing as a continuation of the lateral aspect of the head, tapers mesally and joins with the other faces to terminate in an acute apex.

The inner margin of the right mandible (Pl. II, Fig. 11) is convex in the basal region but is concave for about one third of the distance to the apex. The basal portion of the convex area is the *submola* (smo). The anterior region of the convex and posterior of the concave margin is the *mola* (mo). The apical portion of the mesal edge is the *incisor region* (in).

The left mandible (Pl. II, Fig. 12) differs from the right in that the basal portion of the inner margin gradually curves convexly and terminates in an acute tooth, the *mola* (mo), which is about midway between the base and apex of the mandible. From the mola the mesal edge extends laterally toward the outer surface, then turns and extends vertically for a short distance to the apex.

On the anterior face of each mandible a sharp edge runs dorsally for a short distance from the mid-submolar region parallel with the mesal edge, reverses its course for a short way, goes laterally toward the outer margin, turns and extends not quite parallel with the outer margin to the apex. On the anterior surface of each mandible is a *brustia* (br), or row of setæ, which is adjacent to the submola and curves inward to the second turn of the edge just referred to.

The basal portion of each mandible is triangular in shape. Each mandible has two articulatory points for movement, the *ginglymus* (g) and *condyle* (c). The ginglymus is at the anterior end of the lateral edge. This is a depression, or socket, which fits over a condyle-like projection in the latero-basal edge of the clypeus, forming a ball and socket articulation. The posterior end of the lateral edge bears a well developed condyle which fits into a socket in the latero-ventral margin of the postgena. There are two tendons to furnish movement of the mandibles. An *extensor tendon* (et) extending from the mid-portion of the basal edge of the lateral face to the head opens the mandible, while a *flexor tendon* (ft) from the meso-basal region of the mandible closes it.

At the base of each mandible may be seen a small U-shaped sclerite, the *basimandibula* (bm). If we are to accept the idea of Crampton (1921) in his study of the external anatomy of the head of insects, this plate was probably formed by a sclerotization of a part of the mandibular membrane between the base of the mandible and the head capsule.

Maxilla (mx) (Pl. I, Fig. 4: Pl. II, Fig. 9) :— The maxillæ are ventrad of the mandibles. Each maxilla consists of five principal parts and two free portions. The primary parts are the cardo, stipes, palpifer, basigalea, and distigalea. The free portions are the lacinia and labial palp.

The cardo, or basal sclerite, is divided into the *basicardo* (bc) and *disticardo* (dc). The disticardo is long and quadrangular. The basicardo is smaller and has a convex anterior edge. The meso-basal portion of the disticardo bears a prominent articulatory condyle. The *stipes* (st) is a large subquadrangular sclerite forming the intermediate portion of the maxilla. Two narrow strips, not demarked by distinct sutures, lie along the inner and outer margins of the stipes.

The *palpifer* (pfr) is on the latero-distal angle of the stipes. The *maxillary palp* (mp) is borne by the palpifer and is composed of five segments. The two basal segments are subequal in size, the second being the smaller, but shorter than the three terminal ones. These three are also subequal, the apical one being the longest and pointed at the tip.

The galea, or external lobe of the maxilla, is composed of two segments, the *basigalea* (bg) and *distigalea* (dg). According to Crampton (1923), the division of the galea into a basigalea and distigalea is a primitive survival that has been retained in the Neuroptera. The basigalea is the proximal U-shaped sclerite. The distigalea is much larger with the outer margin curving mesad. The apical region is clothed with hairs. The apical portion of the distigalea is not so heavily sclerotized as the rest of the sclerite.

The lacinia, or inner maxillary lobe, attached to the distal end of the stipes is mesad of the galea. It is composed of two parts, the *basilacinia* (bl) and *distilacinia* (la). The basilacinia is distad of the stipes, weakly sclerotized basally and more heavily sclerotized apically. The outer edge is sclerotized, giving a stiffening effect to the less heavily sclerotized distilacinia. The outer margin of the distilacinia sweeps downward and then upward in a broad curve while the inner margin extends downward and then mesad, both margins terminating at the broad mesal edge. There is a small group of hairs on the posterior portion of the mesal edge.

Labium (Pl. II, Fig. 10) :—The basal sclerite of the labium is largely made up of the *submentum* (sm), although the posterior region of the basal sclerite contains the *gular region* (gu). The submentum has a broadly and sinuately incised anterior margin. In front of the submentum is a membranous area, which is bounded anteriorly by a convexly curved, narrow sclerite, the *mentum* (mn).

In front of the mentum is a small triangular region, the *interlabium* (il). The *palpigers* (pgr) are on each side of the interlabium, and the area between these and the interlabium is not so heavily sclerotized as the palpigers and interlabium. Each palpiger bears a three segmented *labial palp* (lp); the first segment is shortest, the second is longer, and the third is the longest and is pointed at the tip.

Anterior to the palpigers is a slightly sclerotized area which merges into a heavily sclerotized *labiostipes* (lst). The lateral margins of the labiostipes curve outwardly, making the distal end broader than the basal end. The glossæ and paraglossæ

have fused and form a large *membranous lobe* (pg) surrounding the labiostipes. The distal edge of this lobe is truncate and the lateral edges are deflexed posteriorly.

Thorax and its Appendages

The thorax bears the legs and wings and, because of this, great stress is brought upon it by the movement of these appendages. To allow for this stress some of the body wall is membranous, thus permitting its movement. The principal membranous regions are the cervix, prothoracic pleural region, intersegmental regions, and the regions at the articulation of the wings and legs. The apodemes are sclerotized internal ridges for muscle attachment.

There are two *spiracles* (sp) in the thorax, one in the mesothorax and one in the metathorax. The mesothoracic spiracle is situated in front of the mesopleuron. It is a slit-like opening in the body wall, surrounded by a rather oblong-shaped sclerite, the peritreme. The metathoracic spiracle is in front of the metapleuron. This is a circular aperture in the body wall, encircled by a sclerotized plate.

The papers of chief help in a study of the thorax and its appendages are those of Snodgrass (1909 and 1927) and Crampton (1909, 1914 and 1926). Martin's paper (1916) on the thoracic and cervical sclerites of insects is also of interest.

Cervix (Pl. III, Fig. 16):—The cervix, or neck region, is membranous and contains three intersegmental plates, or cervicalia. The *dorsal lateral cervicale* (dlc) is a medium-sized triangular plate in front of the pronotum. According to Crampton (1914), the dorsal lateral cervicale is probably a detached plate belonging to the segment in front of it.

There are two lateral cervical sclerites in the pleural region. The *laterocervicale* (lc), the largest of the cervical plates is ventrad of the dorsal cervicale. The *postcervicale* (poc) is a small, oblong sclerite postero-dorsad of the laterocervicale and appears cut out leaving a concavity into which the postcervicale may go when the head moves to one side.

Prothorax (Pl. III, Fig. 16):—The prothorax appears as an elongated, depressed segment. The *pronotum* (pn) has a slight

mesal depression, is broader than long, and is rounded at its anterior end.

Of the two pleural sclerites, the *episternum* (es), which is ventrad of the lateral edge of the pronotum, is an elongated sclerite narrowed anteriorly and broadened posteriorly. The anterior end is forked and the dorsal end of the postcervicale fits into the crotch. The *epimeron* (em), which is posterior to the episternum, is a narrow sclerite elongated in a dorso-ventral direction. The greater portion of the pleuron is membranous.

The *basisternum* (bs) is a large sclerite somewhat diamond-shaped with the posterior portion narrowed for a short distance and then broadened caudad, forming the *furcasternum* (fs).

There is no precoxal bridge uniting the sternal region with the pleural region. Crampton (1926) gives an excellent discussion of the precoxal bridge in Neuroptera. According to his theory, the absence of this bridge in *Chrysopa perla* gives a condition suggestive of the tendencies exhibited by the higher Holometabola.

Mesothorax (Pl. III, Figs. 14, 16) :—The tergum is divided into a pretergite, prescutum, scutum, scutellum, parascutellum, postergite, and postscutellum. The sutures separating the tergal sclerites are for the most part slightly depressed, giving an arched appearance to the sclerites.

A *marginal sclerite* (ms) which is anterior to the *pretergite* (prt) is probably a demarked portion of the tergum of the mesothorax. The pretergite is a narrow sclerite anterior to the *prescutum* (psc). The prescutum is a larger triangular arched plate laterally and posteriorly demarked from the *scutum* (sc) and mesally demarked from the pretergite on the other side. The scutum, the largest tergal plate, forms a broadly-rounded, elevated median lateral area and narrows in the dorso-median region. The lateral edges of the scutum are fused anteriorly with the prescutum and posteriorly with the *scutellum* (sl) and *parascutellum* (ps). Situated anteriorly and laterally, the scutum bears a rounded articulatory process, or *suralare* (1), with which the wing veins articulate by means of a small movable articulatory plate, the *notopterale* (ax). Behind the suralare is a slight indication of a weakly developed *median articulatory*

process (6). This median process extends toward the notopterale and forms a second anterior notal pivotal point for the wing. The scutellum is caudad of the scutum and is the second largest mesothoracic tergal sclerite. The scutum and scutellum are separated along the line of the internal V ridge which, according to Snodgrass (1909), is typical of the Neuroptera. Externally, no suture can be seen separating the scutellum from the parascutellum which is laterad of it. A narrow, posterior, marginal sclerite, the *postergite* (pot), which is raised on its lateral surface, bears at its antero-lateral edge an *adanal process* (2) which forms a posterior notal point for the wing. The posterior tergal sclerite, the *postscutellum* (psl), is connected with the pleural region and internally bears the *phragma* (pm) (Fig. 14).

The basal alar region is a membranous area in which are seven sclerotized plates, or ossicles; namely, the tegula, notopterale, medials and basanals which are dorsal, and the intraalare, posterior basalar plate, and subalar plate which are ventral.

The *tegula* (tg) is a small triangular sclerite which is anteriorly located. The so-called first axillary, or *notopterale* (ax), is a slightly larger, somewhat triangular ossicle caudad of the anterior articulatory process, or suralare. According to Crampton (1928a), the notopterale is apparently a detached portion of the lateral margin of the notal region. The notopterale is hinged by its inner margin to the edge of the tergum, with its anterior part supported by the suralare. It also articulates with the median process. The outer margin articulates with the *medial plates* (not figured) which Snodgrass (1927) believes may be derived from the proximal end of the radial vein with which they are continuous. The third axillary, or *basanal* (not figured), is the smallest and articulates with the posterior, or adanal wing process of the tergum. The outer edges of the basanal are associated with the bases of the anal veins.

Immediately dorsad of the anepisternum is the *intraalare* (not figured). The *posterior basalar plate* (aba) is ventrad of the suralare. The largest alar sclerite is the elongated *subalar plate* (sa) located ventro-caudad of the posterior basalar plate.

The pleuron of the mesothorax is divided into an anterior portion, the episternum, and a posterior portion, the epimeron. These in turn are subdivided into smaller sclerites.

The episternum and epimeron are separated by the pleural suture which extends from the pleural wing process, or *alifer* (o), to the pleural coxal process, or *coxifer* (5). Crampton (1909) applies the terms *anepisternum* (aes) and *katepisternum* (kes) to the upper and lower regions respectively of the episternum. These are separated by a narrow strip which represents the median part of the episternum. Crampton (1914) brings forth the view that such a strip is probably part of the episternum which has become fused with the sternum to form a precoxal bridge. This whole region is designated as the *mesosternum* (s). A division demarking the anepisternum is retained, but the region below it uniting with the sternum is not demarked from the latter. This composite region, called the sternopleura, is composed of the region below the anepisternum fused with the sternum. The posterior portion of the mesosternum together with the anterior portion of the katepisternum furnishes an *articulatory process* (4) for the coxa. The katepisternum ventrally appears to bear the *trochantin* (tn) which is an elongated sclerite extending ventro-anteriorly. From an external view a true suture cannot be seen separating the katepisternum and trochantin, but an internal view of this shows clearly that such a suture is present. Crampton (1914) suggests that the trochantin may possibly be a detached sclerite of the pleural plate, though others suggest that it (and the pleural sclerites also) represents detached portions of the leg.

The epimeron which is posterior to the episternum is likewise divided into an upper region, the *anepimeron* (aem), and a lower region, the *katepimeron* (kem). These terms were proposed by Crampton (1909). The epimeron is not so definitely subdivided as the episternum. A suture extends from the posterior edge in a ventro-anterior direction for a distance of about half the width of the epimeron, thus only partially subdividing it into its two parts. The anepimeron is much larger than the anepisternum and the katepimeron is much smaller than the katepisternum. The epimeron is more heavily sclerotized on its ventral and lateral edges. Dorsally, the anepimeron is deeply incised for the reception of the basalar and subalar plates. The dorso-anterior portion of the anepimeron which is

the pleural fulcrum, or alifer, of the wing is slightly notched. The anepimeron also dorsally bears an *articulatory process* (3) for the posterior portion of the wing base.

The coxa of the mesothoracic leg is much larger than that of the prothoracic leg. It consists of a *eucoxa* (ecx) and a *meron* (me). The meron, which is well developed in *Chrysopa perla* is a demarked posterior basal lobe of the coxa. The eucoxa is the larger and makes up the rest of the coxa. The coxa articulates with the coxal bearing process (4) and the coxifer (5).

Metathorax (Pl. III, Figs. 15, 16) :—The tergum is composed of a pretergite, prescutum, scutum, scutellum, parascutellum, postergite, and postscutellum.

Externally the *marginal sclerite* (ms), which is probably a demarked portion of the metathoracic tergum, and the *pretergite* (prt) are not seen when the parts are in their natural position, but upon examination of the endoskeleton these can be plainly brought to view. The *prescutum* (psc) is a narrow sclerite which posteriorly fuses with the *scutum* (sc). The scutum is the largest tergal sclerite and appears to occupy the greater part of the metathoracic tergum as compared with the scutum of the mesothoracic tergum. Situated anteriorly and laterally, the scutum bears a rounded articulatory process, or *suralare*, (1) with which the wing veins articulate by means of a small movable articulatory ossicle, the *notopterale* (ax). Behind the suralare is a slight indication of a weakly developed *median articulatory process* (6). This process extends toward the notopterale and forms a second anterior notal pivot for the wing. The posterior tergal sclerite, the *postscutellum* (psl) connects with the pleural region. The *phragma* (pm) is internally borne by the postscutellum.

The alar region of the metathorax is like that of the mesothorax. This membranous area has the seven following ossicles: the tegula, notopterale, medials and basanals which are dorsal, and the intraalare, posterior basalar plate and subalar plate which are ventral.

The *tegula* (tg) is a small anterior triangular sclerite, while the *notopterale* (ax) is a slightly larger, somewhat triangular ossicle caudad of the suralare. The notopterale on its inner

margin articulates with the suralare and median process, and on its outer margin with the *medial plates* (not figured) which are at the base of the radial vein. The smallest axillary, the *basanal* (not figured), is at the bases of the anal veins and articulates with the adanal wing process.

The *intraalare* (not figured) is dorsad of the anepisternum. Immediately ventrad of the suralare is the *posterior basalar plate* (aba). The elongated *subalar plate* (sa) is ventro-caudad of the posterior basalar plate.

The pleural region is divided into an episternum and epimeron which are separated by the pleural suture. This suture extends from the *alifer* (o), or pleural wing fulcrum, to the pleural coxal process, or *coxifer* (5).

In the episternum the upper portion, or *anepisternum* (aes), is separated from the lower portion, or *katepisternum* (kes), by an intermediate strip of the episternum which unites with the *metasternum* (s), similar to that separating the corresponding sclerites in the mesothorax.

As is the case in the mesothorax, the katepisternum ventrally appears to bear the *trochantin* (tn). The ental surface shows a clearly marked suture separating these. The posterior portion of the metasternum together with the anterior portion of the katepisternum furnishes an *articulatory process* (4) for the coxa.

The metathorax differs from the mesothorax in that the division of the epimeron into its subregions, *anepimeron* (aem) and *katepimeron* (kem) is made by a complete suture whereas in the mesothorax the corresponding suture extends only half way across the epimeron. The metathoracic anepimeron is smaller than the mesothoracic anepimeron, while the metathoracic katepimeron is larger than the mesothoracic katepimeron.

The postscutellum of the mesothorax which is continued posteriorly in the *first abdominal tergite* (lt) extends ventrally and encloses the *first abdominal spiracle* (sp). The region surrounding the spiracle unites with the metathoracic epimeron at the posterior end of the suture which divides it into two parts.

The metathoracic coxa is divided into two regions, a posterior basal lobe, the *meron* (me), and an anterior larger portion, the *eucoxa* (ecx).

Endoskeleton of the meso- and metathorax (Pl. II, Fig. 13; Pl. III, Figs. 14, 15):—The endoskeleton is composed of inwardly directed processes, or apodemes, which serve for muscle attachment and for the support of other viscera.

In the tergal region of the mesothorax (Fig. 14) internal foldings, or ridges, can be seen demarking the various tergites. The infolding of the body wall along the median line between the *marginal sclerites* (ms) and *prescutums* (psc) of both sides forms an internal median ridge. The internal ridge demarking the scutellum and *parascutellum* (ps) is very prominent yet there is no indication of such a demarkation externally. This ridge is formed by the infolding of the body wall between the scutellum and parascutellum. The *postscutellum* (psl) bears an internal lobe, the *phragma* (pm).

The metathoracic tergal region (Fig. 15) shows no median ridge dividing the marginal sclerite and prescutum. There is a very distinct ridge separating the prescutum and scutum. The ridge demarking the scutum from the parascutellum is not as broad as the corresponding ridge in the mesothorax. The metathoracic phragma is small and ventrad of the postscutellum, while that of the mesothorax is large and caudad of the postscutellum.

In the pleural region an apodeme, the *pleural ridge* (pr), extends from the *alifer* (o) to the *coxifer* (5). This ridge is formed by an infolding of the body walls between the episternum and epimeron and is the largest apodeme in the endoskeleton. The pleural ridge gives off a *pleural arm* (pa) which extends to and fuses with the furcal arm, or *furca* (f) of the sternum. The pleural ridge serves as attachment for the muscles extending to the trochantin and coxa.

In the mesothorax, the epimeron is bounded posteriorly by a broad internal ridge, whereas there is no such ridge on the metathoracic epimeron. Both the meso- and metathoracic anepisterna bear an inner dorso-anterior plate.

The metathorax differs from the mesothorax in that the division of the epimeron into its subregions, anepimeron and katepimeron, is represented by a complete ridge whereas in the mesothorax the corresponding ridge extends only half way across the

epimeron. The *trochantins* (tn) of both the meso- and metathorax are distinct sclerites demarked from the katepimera.

The *meso-* and *metasterna* (s) in figure 16 seen from within are made up of three parts, namely, the laterosternum, basisternum and furcasternum. The *laterosternum* (ls) unites ventro-mesally with the *basisternum* (bs), which in its median portion is rolled inward as a well defined ridge. The ridge separating the posterior region of the laterosternum from the anterior portion of the katepisternum is clearly demarked. The *furcasternum* (fs) is caudad of the basisternum and like it bears an internal apodeme. The furcasternum posteriorly extends into a furcal arm, or *furca* (f).

The position and shape of the phragma and furca of the mesothorax are shown in figure 13.

Legs (Pl. II, Figs. 5, 6):—The mesothoracic leg has been chosen for discussion but the marked differences between this and the other legs will be brought out.

The coxa, or proximal segment, has the appearance of a truncated cone. It is divided into a large anterior portion, the *eucoxa* (ecx), and a smaller demarked basal lobe, the *meron* (me). The meron never takes part in the trochanteral articulations (Snodgrass 1927). The coxa articulates with the coxal bearing process and coxifer of the mesopleuron. The distal end of the eucoxa bears three *articulatory processes* (1, 2, 3) for the trochanter. The coxa of the prothoracic leg is much smaller and consists of two small elongated sclerites, the smaller anterior one being the eucoxa, and the larger posterior one, the meron.

The second segment of the leg is the *trochanter* (tr) which is a small quadrangular segment immovably joined to and sharply demarked from the *femur* (fe).

The femur and the following segment, the *tibia* (ti), are elongated cylindrical segments. The distal end of the tibia articulates with the *tarsus* (ta). On the ventral portion of the tibia at its distal end is a movable *tibial spur* (tis).

The tarsus is composed of five segments, the two terminal ones being the longest. The last tarsal segment, or distitarsus, bears the claws, or *ungues* (pta), and the *arolium* (ar). The ungues are hooked at the base and are connected ventro-basally with

the sclerotized plate which is separated from the ventro-distal portion of the last tarsal segment by a membranous portion.

Ventrad of the distal portion of the distitarsus is a pad-like structure, the arolium. Two bristles extend dorso-distad from the membrane between the prætarsus and the last tarsal segment.

Wings (Pl. I, Figs. 1, 2):—The venation of *Chrysopa perla* is highly specialized, and a correct interpretation of that of the adult can best be understood by first considering the pupal tracheation. However, as such a study was impossible in the time available for the preparation of the present thesis, the writer has adopted the conclusions of Tillyard (1916) and Smith (1922), who have described the wing venation of *Chrysopa signata*, *Chrysopa nigricornis* and *Chrysopa oculata* on the basis of the tracheation of the pupa.

The following quotation from Tillyard (1916) summarizes our present knowledge of the specialized venation in the family Chrysopidæ:

> "The solution shows us, indeed, that the wing-venation of the *Chrysopidæ* is not only, as Petersen suspected, 'the most abnormal of all the families,' but that it is indeed one of the most abnormal and highly specialised venations to be found within the Insecta. Judged from this standpoint, the *Chrysopidæ* stand far and away above all other Neuroptera in the effect and extent of their wing-specialisation."

The system of nomenclature here adopted is a combination of the Comstock-Needham and Tillyard interpretations. The tracing of the veins is in accordance with the views of Tillyard (1916), while the nomenclature of Comstock and Needham has been applied to the main veins. The cells are given the terms proposed by Tillyard.

In the Chrysopidæ the original media and cubitus have become reduced and contorted. The two resultant veins, the so-called pseudomedia and pseudocubitus, have become excessively complex and are peculiar to this family.

The *costa* (C) is the anterior marginal vein. The *subcosta* (Sc) appears to end beyond the pterostigma and near the tip of the wing. However, pupal tracheations of other species show

Modification of Comstock-Needham and Tillyard Systems		Tillyard Notation *C. signata*	Comstock-Needham Notation *C. nigricornis*	
Costa	C	C	C	
Subcosta	Sc	Sc	Sc	
Pterostigma	pt	pt		
Radius	R	R	R	
1st radial	R_1	R	R_1	
2d radial	R_2	B_1		
3d radial	R_3	B_2	R_{2a}	
4th radial	R_4	B_3	R_3	
5th radial	R_5	B_4	R_4	
6th radial	R_6		R_5	
Radial sector	Rs	Rs	Rs	R_2 at the margin
Median	M	M	M	
1st media	M_1	M_1	M_1	
2d media	M_2		M_2	
3d media	M_3	M_2	M_3	
4th media	M_4		M_4	
Pseudomedia	M^1	M^1	M^1	
Cubitus	Cu	Cu	Cu	
1st cubitus	Cu_1	Cu_1	Cu_1	
2d cubitus	Cu_2	Cu_2	Cu_2	
Pseudocubitus	Cu^1	Cu^1	Cu_1^1	
1st anal	1A	1A	1A	
2d anal	2A	2A		
3d anal	3A	3A		
Inner gradate series	g	g		
Outer gradate series	g^1	g^1		
Distal forks	df	df		
Posterior branches from radial sector	s_1–s_{12}	s		
Subcostal cross vein	x	Scx		
Origin of radial sector	rf	rf		
Medial fork	mf	mf		
1st cubital fork	cuf	cuf		
2d cubital fork	cuf^1	cuf^1		
Radial cell	r			
Upper series of Banksian cells	b	b		
Lower series of Banksian cells	b^1	b^1		
1st medial cell	m_1	m_1		
2d medial cell	m_2	m_2		
3d medial cell	m_3	m_3		
1st intramedial cell	e_1	im_1		
2d intramedial cell	e_2	im_2		
Cubital cell	cu	cu		
1st intracubital cell	u_1	icu_1		
2d intracubital cell	u_2	icu_2		
3rd intracubital cell	u_3	icu_3		
Posterior series of cells	p	p		

that the subcosta ends at the inner border of the pterostigma, and in the adult the stigmal cross-veinlets have fused giving Sc the appearance of extending nearly to the wing tip. There are many veinlets between the costa and subcosta. The main *cross-vein* between the subcosta and radius is at (x) in the fore wing although there are a few cross-veins between the terminal portions of these main veins. The *pterostigma* (pt) is a membranous area between the costa and radius near the tip of the wing.

The *radius* (R) is a well-developed vein running parallel with the subcosta. The radial vein is forked as it reaches the margin. The *radial sector* (Rs) in the fore wing arises from the radius at the *radial fork* (rf), a considerable distance from the base of the wing; in the hind wing the origin is nearer the base. The radial sector gives off several posterior branches which vary in number. In the figure given these are s_1–s_{12} in the fore wing and s_1–s_{11} in the hind wing. The first seven in the fore wing and the first six in the hind wing extend straight to the margin. The other five (R_2, R_3, R_4, R_5, R_6) are bent in their midportions and run longitudinally forming the distal portion of the *pseudomedia* (M^1). Four of these (R_3, R_4, R_5, R_6) drop below the level of the pseudomedia, become bent again and run longitudinally forming the distal end of the *pseudocubitus* (Cu^1). Three of these (R_4, R_5, R_6) drop to the wing margin. It may be noted that R_1, R_2, R_3, R_4, R_5 and R_6 are two-branched at the wing margin. The fifth and sixth radial veins (R_5 and R_6) are often three-branched. The radial sector although often two-branched at the tip is usually unbranched.

The *radial cell* (r) is a simple cell lying between the main stems of R and M. The cells formed between the radial sector and pseudomedia by R_2 through R_6 inclusive are called the ***upper series of Banksian cells*** (b–b), and those formed below, between the pseudomedia and pseudocubitus by R_3 through R_6 inclusive are termed the ***lower series of Banksian cells*** (b^1–b^1). In the hind wing the first upper Banksian cell is that just distad of the ***triangular cell*** (t), which is really a rudiment of the first cell. This triangular cell is formed by Rs, R_6 and M_{1+2}. In the twelve specimens at hand an excellent series of gradations, from

a large triangular cell to no cell at all, were found. This decrease in size and final obliteration of the cell is due to the encroaching of the radial sector and sixth radial (R_6) vein on the media. The triangular cell, although absent in this particular specimen (No. 9) (Fig. 2), has been drawn in to show its general position.

The *media* (M) fuses basally with the radius for a distance, then diverges and runs to the *median fork* (mf) which in the fore wing is below and proximad of the radial fork, while in the hind wing it lies immediately below it. At the medial fork two branches (M_{1+2} and M_{3+4}) arise. In the fore wing, M_{1+2} arches upward while M_{3+4} extends concavely to it. M_{3+4} is then deflected cephalad and finally unites with M_{1+2} just beyond the radial cross-vein. These two elements then extend longitudinally for a short distance along the pseudomedia. M_{3+4} then drops down to the pseudocubitus, extends longitudinally and finally branches into M_3 and M_4 which reach the wing border. M_{1+2} extends further distad on the pseudomedia, drops to the pseudocubitus, runs distad and then branches into M_1 and M_2 which attain the border.

In the hind wing M_{1+2} and M_{3+4} separate at the medial fork. M_{1+2} arches upward and comes close to the radial sector, then extends longitudinally along the pseudomedia and drops to the pseudocubitus. M_{3+4} extends parallel to and below M_{1+2} and meets this when it drops to the pseudocubitus. These two extend longitudinally a short distance, then M_{3+4} splits into its component parts, M_3 and M_4, which drop to the wing border. M_{1+2} extends further distad and then breaks up into its component parts, M_1 and M_2, which likewise extend to the margin. M_1, although usually simple, is often two-branched at the margin.

The cells formed by cross-veins between the media and cubitus are the *medial cells*. There are three (m_1, m_2, m_3) in the fore wing and two (m_1, m_2) in the hind wing. Cells formed by the forking of M_{1+2} and M_{3+4} are the *intramedial cells* (e_1, e_2) in the fore wing. In the hind wing these are formed by a cross-vein dividing the large intramedial cell into its two component cells (e_1, e_2).

The *pseudomedia* (M^1) in the fore wing arises from R near the base. It is formed by M up to mf, beyond this by M_{1+2} above e_1, then by M_{1+2} and M_{3+4} united for half a cell's length, then by M_{1+2} and R_6 united for a short distance, then by R_6, R_5, R_4, R_3, R_2 overlapping each other in turn, and terminates in R_2 alone.

The *cubitus* (Cu) starts as a single vein basally. In the front wing it runs almost straight until it meets M_{3+4} as it drops onto the pseudocubitus. Cu_1 gives off three branches to the wing border. At the *cubital fork* (cf) which is proximad of the first cross-vein between the media and cubitus, one branch (Cu_2) is given off and swings down, soon sending two branches to the margin.

In the hind wing the cubitus branches at the *first cubital fork* (cf) which is closer to the base than it is in the fore wing. Cu_2 swings down and then as a single branch goes in a gentle curve to the margin. Cu_1 extends on a distance and again forks at the *second cubital fork* (cf^1), one branch going to the margin, the other up to the pseudocubitus and finally dropping two branches to the margin. (In the figure shown, one branch is dotted to show that in this particular specimen no such branch is present. One specimen, No. 4, showed that this branch was becoming atrophied as two-thirds of it was entirely gone. The other ten specimens had two entire branches.)

The *cubital cell* (cu) is a simple cell lying between the main stems of the cubitus and first anal. There are two cross-veins between Cu_1 and Cu_2 in the fore wing forming three *intracubital cells* (u_1, u_2, u_3), and one in the hind wing forming two intracubital cells (u_1, u_2). In both wings there is a short cross-vein between Cu_2 and 1A just distad below the first cubital fork. In the hind wing, however, Cu_2 appears as part of 1A and the cross-vein in some cases is so short that these veins appear to adjoin each other.

The *pseudocubitus* (Cu^1) in the fore wing arises from the base of the wing and extends to cf as the main stem Cu. Beyond cf it is composed of Cu_1, M_4, M_3, M_2, M_1, R_6, R_5, R_4, R_3 overlapping each other in turn, and terminates in R_3 alone.

In the hind wing it arises near the base of the wing from R. It is formed by M for a short distance, then by M and Cu_1 united

up to mf; beyond this by M_{3+4} and Cu_1 united for over a cell's length, then by M_{3+4}, M_{1+2}, R_6, R_5, R_4, R_3 overlapping each other in turn, and terminates in R_3 alone.

In both wings there are three anal veins. In the fore wing the *first anal* (1A) is two-branched, the *second anal* (2A) is also branched but the proximal branch unites with the *third anal* (3A). 3A is unbranched but has a double curvature causing it to come in contact with the margin of the wing between the base and the anal angle. A short cross-vein connects 1A with 2A.

In the hind wing all the anal veins are small and inconspicuous as compared with those in the fore wing. All are simple veins, but the third anal sends a small branch to the wing just proximad of the anal angle.

Two longitudinal series of cross-veins connect the posterior branches of Rs from s_1 to R_2. The inner series is termed the *inner gradate* (g), and the outer series. the *outer gradate* (g^1).

The forks at the posterior end of the veins given off by the radial sector and the media are termed *distal forks* (df).

The cells between the proximal branch of Cu_1 and the proximal branch of R_2 are the *posterior series of cells* (p).

A few of the peculiarities present in the wings studied are as follows:

1. In specimens Nos. 1, 10 and 11. In both the fore and hind wings R_2 does not join the pseudomedia until after R_3 has dropped down to the pseudocubitus. The pseudomedia thus consists of a cross-vein between R_3 and R_2. Also a cross-vein has been added from R_2 to M^1, appearing as one of the upper gradate series.

2. In specimen No. 12. In the fore wing a cross-vein is added between R_2 and M^1.

3. In specimen No. 2. In the hind wing the median portion of s_8 has atrophied.

4. In specimen No. 3. In the fore wing s_8 extends to M^1, the remaining portion having atrophied.

5. In specimens Nos. 1, 3, 5 and 12. In the fore wing of No. 3, hind wings of Nos. 1 and 5 and both wings of No. 12, the penultimate portion of R_3 has atrophied. In No. 3, an additional cross-

vein has been added which connects the ultimate portion of R_3 and R_2. Thus the average number of five lower Banksian cells is present. In Nos. 5 and 12, the cross-vein commonly between R_2 and R_3 connects R_3 with R_2, and in No. 1 connects R_3 with M^1. The portion of R_3 between M^1 and Cu^1 is still present. Thus only four lower Banksian cells are present.

6. In specimen No. 7. In the hind wing the portion of M_{1+2} between M^1 and Cu^1 has atrophied, making the second intramedial cell (e_2) longer than usual and reducing the number of lower Banksian cells to four.

7. In specimens Nos. 3, 4, and 9. In the hind wing of No. 4 there are two complete branches of Cu_1 and one about two-thirds atrophied. In Nos. 3 and 9, this branch of Cu_1 that is on its way out in No. 4 has completely atrophied.

Tables I and II show in tabular form the number of main veins and cells in the twelve specimens of *Chrysopa perla* studied. The variation existing within the species is here graphically shown. The numbers opposite the veins represent the number of branches at the margin of the wing. The numbers opposite the cells represent the number of cells in the wing.

The numbers at the top of the sheet refer to the specimens as follows:

No. 1. Sex?, Mondy, Sajan Mts., Siberia; determined by L. Navás
2. Female, Nowgorodow, Baikal, Siberia; determined by L. Navás
3. Male, Waldheim, Saxony, Germany; determined by L. Navás
4. Female, Linz, Austria
5. Female, Braunschweig, Germany
6. Female, Braunschweig, Germany
7. Female, Braunschweig, Germany
8. Female, Braunschweig, Germany
9. Male, Norway
10. Sex?, Norway
11. Sex?, Norway
12. Sex?, Norway

The right wings of specimens Nos. 1–10 inclusive and left wings of specimens Nos. 11 and 12 were studied.

1, 2, 3, 4, 5, 6, 7, 8, through Staudinger and Bang-Haas

9, 10, 11, 12, through Dr. G. C. Crampton

TABLE I

Fore Wings	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	Min.	Max.	Ave.
First radial R_1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Radial sector at margin Rs	2	1	2	1	1	1	1	2	1	1	1	1	1	2	1
Second radial R_2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Third radial R_3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Fourth radial R_4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Fifth radial R_5	2	2	2	2	3	2	2	2	3	2	2	3	2	3	2
Sixth radial R_6	2	3	2	2	2	3	2	2	2	3	3	2	2	3	2
First media M_1	2	1	2	2	1	1	2	2	1	1	1	1	1	2	1
Second media M_2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Third media M_3	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1
Fourth media M_4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
First cubitus Cu_1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Second cubitus Cu_2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
First anal 1A	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Second anal 2A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

TABLE I (*Continued*)

Fore Wings	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	Min.	Max.	Ave.
Third anal 3A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Posterior branches from radial sector s	11	13	13	13	12	14	11	13	12	12	13	12	11	14	12
Inner gradate series g	5	6	6	7	6	8[1]	5	6	5	5	6	5	5	8	5 6
Outer gradate series g[1]	6[2]	8	7	8	7[2]	9[2]	6	8	7	7	8	7	6	9	7
Distal forks df	10	9	13	12	11	12	10	11	8	9	10	8	8	12	10 12
Upper series of Banksian cells b	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Lower series of Banksian cells b[1]	5	5	5	5	5	5	5	5	5	5	5	4	4	5	5
Radial cell r	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Medial cells m	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Intramedial cells e	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cubital cell cu	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Intracubital cells u	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Posterior series of cells p	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

[1] One double, one Y.
[2] One double.

TABLE II.

Hind Wings	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	Min.	Max.	Ave.
First radial R_1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Radial sector at margin Rs	1	1	2	1	1	1	1	1	1	2	1	1	1	2	1
Second radial R_2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Third radial R_3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Fourth radial R_4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Fifth radial R_5	2	2	2	2	3	2	2	2	3	2	3	3	2	3	2
Sixth radial R_6	2	3	3	2	2	3	2	3	2	3	2	2	2	3	2
First media M_1	2	1	1	2	1	1	2	1	1	1	1	1	1	2	1
Second media M_2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Third media M_3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fourth media M_4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
First cubitus Cu_1	3	3	2	$2\frac{1}{3}$	3	3	3	3	2	3	3	3	2	3	3
Second cubitus Cu_2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
First anal 1A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Second anal 2A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

TABLE II (*Continued*)

Hind Wings	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	Min.	Max.	Ave.
Third anal 3A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Posterior branches from radial sector s	11	13	13	12	12	13	11	12	11	11	12	11	11	13	11
Inner gradate series g	5	5	5	6	6	7	5	6	4	5	5	4	4	7	5
Outer gradate series g'	6	7	7	7	6	7[2]	6	7	6	6	7	6	6	7	6 7
Distal forks df	10	10	10	11	8	11	10	10	8	10	8	9	8	11	10
Upper series of Banksian cells b	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Lower series of Banksian cells b'	4	5	5	5	4	5	4	5	5	5	5	4	4	5	5
Radial cell r	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Medial cells m	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Intramedial cells e	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cubital cell cu	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Intracubital cells u	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Posterior series of cells p	16	16	15	15'	16	16	16	16	15	16	16	16	15	16	16
Triangular cell	1*	1**	1**	1**	1*	1**	1**	1***	0	1**	1**	1'	0	*	**

[2] One double: * large: ** medium: *** small: ' very small.

From a study of this chart the following conclusions on the venation of *Chrysopa perla* have been drawn.

1. Veins found to be constant:

A. In both the fore and hind wings the following are present.

Costa
Subcosta
6 Radial veins
Radial sector
4 Medial veins
2 Cubital veins
3 Anal veins

B. Veins in both the fore and hind wings with constant number of marginal branches.

Veins	Number of marginal branches	
	Fore Wing	Hind Wing
R_1	2	2
R_2	2	2
R_3	2	2
R_4	2	2
M_2	1	1
M_3	1	1
M_4	1	1
Cu_1	3	variable
Cu_2	2	1
1A	2	1
2A	1	1
3A	1	1

2. Cells found to be constant:

A. Cells in both the fore and hind wings.

Cells	Number of cells	
	Fore Wing	Hind Wing
Upper series of Banksian cells	5	4
Radial cell	1	1
Medial cell	3	2
Intramedial cell	2	2
Cubital cell	1	1
Intracubital cell	3	2
Posterior series of cells	16	variable

It may be noted that in both the fore and hind wings great variation occurs in the number of inner and outer gradates and in the number of posterior branches from the radial sector. There is also variation in the number of branches borne by R_5, R_6 and M_1; if one is three-branched, the other two are two-branched.

Tillyard (1916) in discussing the wing venation of the Chrysopidæ lists a few venational differences on which he considers sound species of *Chrysopa* may be based. From the present study of the venation of *Chrysopa perla,* some of the characters listed by Tillyard are found to vary greatly within the species and so may be considered as being of doubtful value for specific purposes. These doubtful characters are as follows:

1. Number of free sectors; number of cells between R and Rs.
2. Number of closed cells beyond the arculus (proximal portion of the first intramedial cell) in the space between M^1 and Cu^1 in the fore wing; the number of same beyond mf in the hind wing.
3. Number of distal forks (df); the number of simple posterior cells (p) before the most proximal distal fork.
4. Number of gradate veins in both the inner and outer series.

Abdomen and its Appendages

The abdomen (Pl. IV, Figs. 17, 18, 19, 20, 21, 22) is composed of eight distinct spiracle-bearing segments followed by a ninth which is highly modified as the genital segment. The terminal segments are so indistinguishably united it is impossible to determine them.

The dorsum has a series of nine tergites (1t–9t). The *first abdominal tergite* (1t) is short and the anterior portion extends ventrally into the pleural region and bears the *first abdominal spiracle* (sp). The region surrounding the spiracle is connected with the metathorax by an extension of the metathoracic epimeron. Tergites two to seven inclusive are approximately equal in length. The *second tergite* (2t) is distinctly divided into two plates while the five following tergites show only a slight tendency toward division. Tergites two to eight inclusive of the male and two to seven inclusive of the female are subequal. The *eighth tergite* (8t) of the female is short.

The pleuron, or the membranous region between the tergites and sternites, is very distinct in *Chrysopa perla.* The *spiracles* (sp) are small semi-circular openings and are found in the first eight pleurites.

The ventral region has a series of seven sternites in the female (Figs. 17, 19) and eight in the male (Figs. 20, 22). The *first sternite* (1s) is short and, from its postero-dorsal region, a sclerotized rod extends dorso-cephalad into the pleural region. Ventrad of this rod another rod not connected with the sternite extends parallel to it. Sternites two to seven inclusive are subequal. The eighth sternite of the male is about half the size of the seventh.

Female Genitalia (Figs. 17, 18, 19) :—The ninth tergite has apparently been retained and extends ventrad to form the valves (Pariser 1919). In *Chrysopa vulgaris* (Pariser 1919), the ninth tergite shows no secondary division cephalad of the *sensory area* (a). However, *Chrysopa perla* has a distinct suture in the lateral region, which is continued dorsad in some as a very faint suture and in others as a very distinct suture. This would seem to indicate that the ninth tergite has become secondarily divided into an anterior and posterior region. Crampton (1929) calls this posterior area in *Raphidia notata* the tenth tergite. Stitz (1909) shows the female of *Chrysopa perla* (Taf 29, Fig. 131) as having a transverse suture dividing the ninth segment into an upper and lower region. Pariser (1919) calls attention to this error. The specimens studied by the writer check with Pariser's observations.

Caudo-ventrad of the valves is a sclerotized area in the mid region of which is a slit-like genital opening, or *gonopore* (gp). Pariser (1919) calls this region the cover plate. Crampton (1929) in figuring *Corydalis cornuta* indicates the possibility that the ventral portion of the ninth tergite may be the proximal portion of the dorsal valve and the cover plate of Pariser the distal portion of the dorsal valve. A membranous protuberance, which in *Corydalis cornuta* (Crampton 1929) is termed the proctiger, is dorsad of the cover plate. The *anus* (an) opens dorsally on the proctiger.

Male Genitalia (Figs. 20, 21, 22) :—The ninth tergite extends cephalo-ventrad. Pariser (1919) in figuring *Chrysopa vulgaris* terms this cephalo-ventral portion the valve. Crampton (1920) calls the corresponding portion of *Nymphes myrmelionides* the gonopleurite, and the dorsal portion containing the *sense areas* (a) the surgonopod. There is an elongated ventral plate which is probably the ninth sternite. Crampton (1918a) terms the corresponding sternite of *Corydalis cornutus* the hypandrium, or subgenital valve. The *lobe-like structure* (b) caudad of the subgenital valve is apparently the sublaminæ (Crampton 1918a). A large membranous genital swelling extends caudad from between the gonopleurite and subgenital valve. On this swelling are three *light gray areas* (k).

The male genitalia of *Chrysopa perla* figured by Stitz (1909) (Taf. 26, Fig. 41) is entirely different from the one figured in this thesis. The specimens used by the writer were compared and found to check with a male determined by Navás as *Chrysopa perla*. This leads the writer to believe that the male genitalia figured by Stitz is that of another species.

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ABBREVIATIONS

a—sense area
aba—posterior basalar plate
aem—anepimeron
aes—anepisternum
an—anus
anf—antennifer
ar—arolium
as—antennal socket
at—anterior arm of tentorium
ax—notopterale

b—lobed portion on male genitalia
bc—basicardo
bg—basigalea
bl—basilacinia
bm—basimandibula
br—brustia
bs—basisternum

c—condyle
cd—cardo
cl—clypeus

dc—disticardo
dg—distigalea
dlc—dorsal lateral cervicale
dt—dorsal arm of tentorium

e—eye
ecx—eucoxa
em—epimeron
es—episternum
esu—epistomal suture
et—extensor tendon

f—furca
fe—femur
fl—flagellum
for—occipital foramen
fr—frons
frp—frontal pit
fs—furcasternum
fsu—frontal suture
ft—flexor tendon

g—ginglymus
ge—gena
gp—gonopore
gu—gula
gup—gula pit

il—interlabium
in—incisor region

k—light spot on male genitalia
kem—katepimeron
kes—katepisternum

la—distilacinia
lc—laterocervicale
li—labium
lp—labial palp
lr—labrum
ls—laterosternum
lst—labiostipes

md—mandible
me—meron
mn—mentum
mo—mola
mp—maxillary palp
ms—marginal sclerite
mx—maxilla

o—alifer
ocp—occiput
os—occipital suture

p—pleurite
pa—pleural arm
pd—pedicle
pfr—palpifer
pg—fused glossae and paraglossae
pgr—palpiger
pm—phragma
pn—pronotum
poc—postcervicale
pot—postergite
pr—pleural ridge
prt—pretergite
ps—parascutellum
psc—prescutum
psl—postscutellum
pt—posterior arm of tentorium
pta—ungues

s—sternite
sa—subalar plate
sc—scutum
scp—scape
sgs—subgenal suture
sl—scutellum
sm—submentum
smo—submola
sp—spiracle
st—stipes

t—tergite
ta—tarsus
tg—tegula
ti—tibia
tis—tibial spur
tn—trochantin
tnt—body of tentorium
tr—trochanter
ts—temporal suture

v—vertex

1, 2, 3, 4, 5, 6—articulatory processes
In Plate I.
1, 2, 3—articulatory processes for trochanter
In Plate III.
1—suralare
2—adanal process
3—articulatory process for wing
4—articulatory process for coxa
5—coxifer
6—median articulatory process

VEINS

C—costa
Sc—subcosta
R—radius
R_1—1st branch of radius
R_2—2d branch of radius
R_3—3d branch of radius
R_4—4th branch of radius
R_5—5th branch of radius
R_6—6th branch of radius
Rs—radial sector
M—media
M_1—1st branch of media
M_2—2d branch of media
M_3—3d branch of media
M_4—4th branch of media
M^1—pseudomedia
Cu—cubitus
Cu_1—1st branch of cubitus
Cu_2—2d branch of cubitus
Cu^1—pseudocubitus
1A—1st anal
2A—2d anal
3A—3d anal
s_1—1st posterior branch from radial sector

s_7—7th posterior branch from radial sector

s_{11}—11th posterior branch from radial sector

s_{12}—12th posterior branch from radial sector

cuf—1st cubital fork

cuf^1—2d cubital fork

df—distal fork

mf—medial fork

rf—radial fork

g—inner gradate series of veins

g^1—outer gradate series of veins

x—subcostal cross-vein

CELLS

b–b—upper series of Banksian cells

b^1–b^1—lower series of Banksian cells

r—radial cell

e_1—1st intramedial cell

e_2—2d intramedial cell

m_1—1st medial cell

m_2—2d medial cell

m_3—3d medial cell

cu—cubital cell

u_1—1st intracubital cell

u_2—2d intracubital cell

u_3—3d intracubital cell

p–p—posterior series of cells

t—triangular cell

pt—pterostigma

PLATE I

Figure 1.—Right fore wing of male.

Figure 2.—Right hind wing of male.

Figure 3.—Antenna.

Figure 4.—Head, frontal aspect.

Figure 5.—Left mesothoracic leg of female, anterior aspect.

Figure 6.—Left mesothoracic tarsus and distal end of tibia of female, ventral aspect.

Figure 7.—Tentorium, mesal view along the median axis.

Figure 8.—Tentorium, caudal aspect.

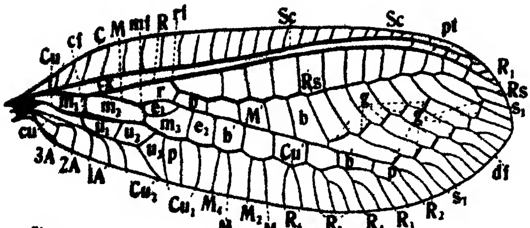

Fig. 1

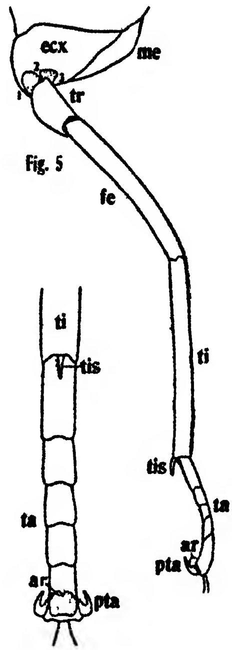

Fig. 5

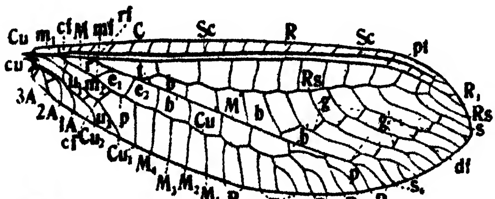

Fig. 2

Fig. 6

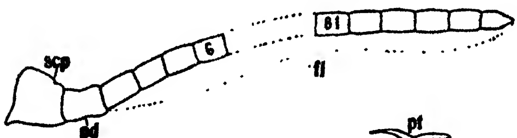

Fig. 3

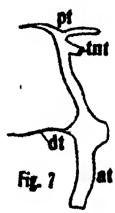

Fig. 7

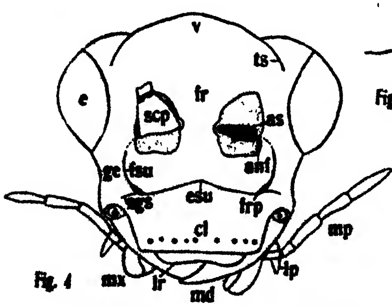

Fig. 4

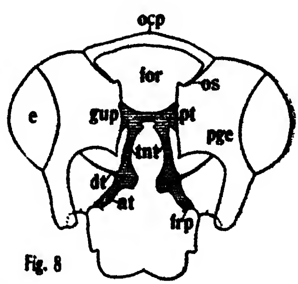

Fig. 8

CHRYSOPA PERLA

PLATE II

Figure 9.—Left maxilla, posterior aspect.
Figure 10.—Labium, posterior aspect.
Figure 11.—Right mandible, anterior aspect.
Figure 12.—Left mandible, anterior aspect.
Figure 13.—Mesothorax, caudal aspect.

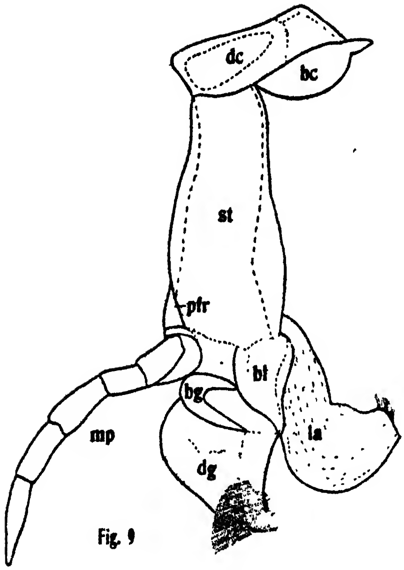

Fig. 9

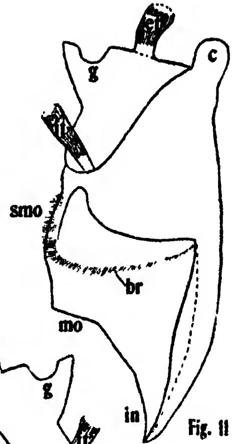

Fig. 11

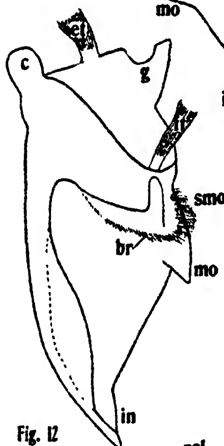

Fig. 12

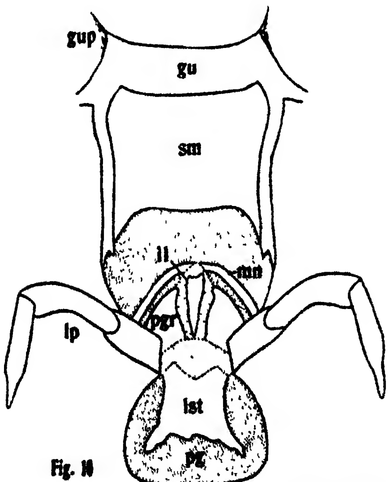

Fig. 10

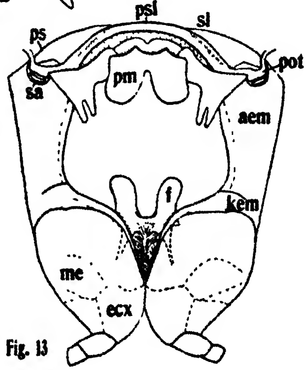

Fig. 13

CHRYSOPA PERLA

PLATE III

Figure 14.—Mesothoracic endoskeleton, lateral aspect.
Figure 15.—Metathoracic endoskeleton, lateral aspect.
Figure 16.—Thorax, lateral aspect.

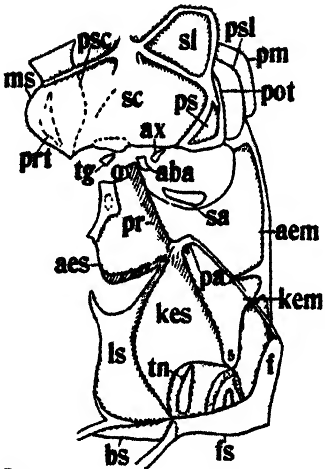

Fig. 14

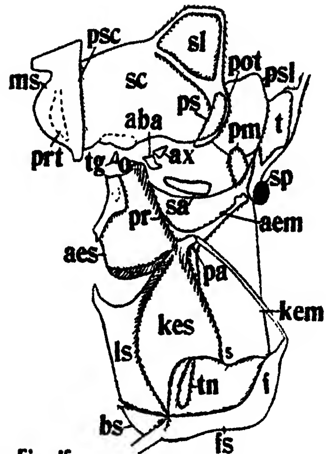

Fig. 15

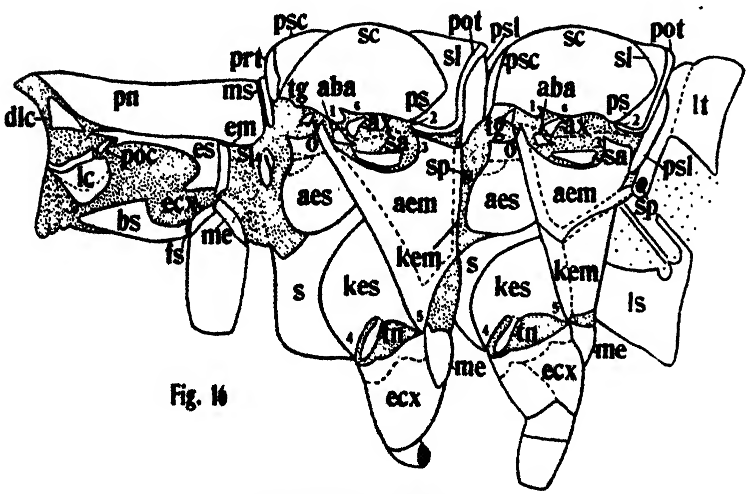

Fig. 16

CHRYSOPA PERLA

PLATE IV

Figure 17.—Abdomen of female, lateral aspect.
Figure 18.—Genitalia of female, dorsal aspect.
Figure 19.—Genitalia of female, ventral aspect.
Figure 20.—Caudal portion of abdomen of male, lateral aspect.
Figure 21.—Genitalia of male, dorsal aspect.
Figure 22.—Genitalia of male, ventral aspect.

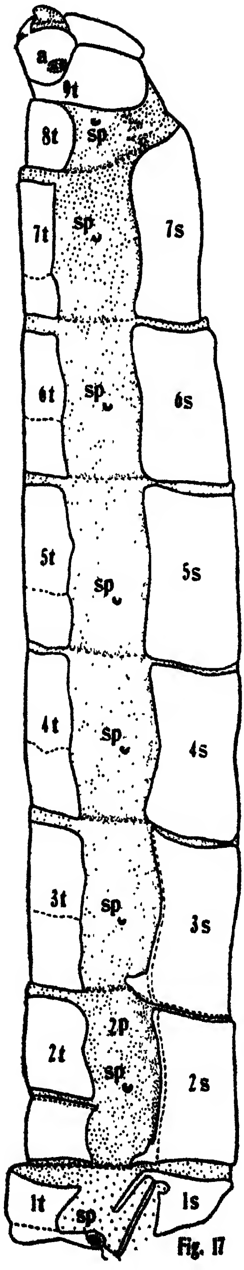

Fig. 17

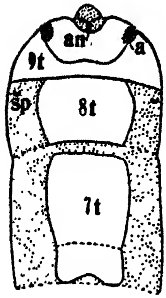

Fig. 18

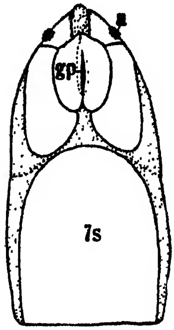

Fig. 19

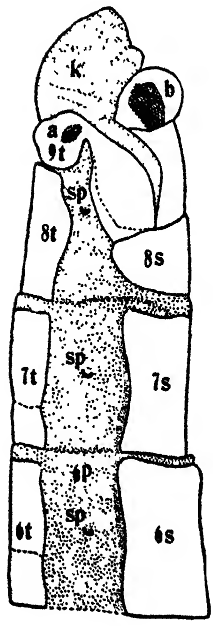

Fig. 20

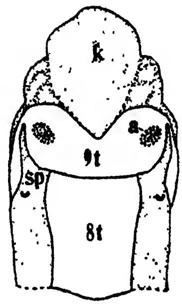

Fig. 21

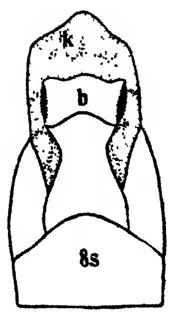

Fig. 22

CHRYSOPA PERLA

THE EPHEMERID GENUS BÆTISCA*

BY JAY R. TRAVER

I. HISTORICAL

This very peculiar and interesting genus, erected by Walsh in 1862 to include Say's *Bætis obesa,* has up to the present time been represented in published accounts by two species, *B. obesa* Say, and *B. rubescens* Prov. Say, in 1839, described the subimago of *B. obesa;* the generic characters were drawn up by Walsh in 1862, from this one species; at the same time Walsh described the imago state, and in 1864 described and figured the nymph, which he had successfully reared. This latter article Joly (1880) translated into French, with annotations. Vayssiere, 1882, compared the nymph to that of *Prosopistoma,* figuring its parts in some detail. Eaton, in his "Recent Ephemeridæ," 1883–88, figured the nymph and all its appendages, likewise the wings, legs, and male genitalia of the imago. Needham, 1905, reported it from New York state, and figured labium and side view of the nymph, and wings of the subimago. Clemens, 1913 and 1915, reported it from Canada. Murphy, 1922, figured some of the mouthparts and included the genus in her discussion of mouthparts of mayfly nymphs in general.

Provancher, 1883, described as *Cloe unicolor* Hagen, later changing the name to *Cloe rubescens,* an imago from Canada having wings reddish at the base and the costal margin, and abdominal segments margined posteriorly with black. This species, placed later in *Bætis,* was transferred to *Bætisca* by McDunnough in 1921.

In this paper are presented two new species of the genus—*B. carolina,* from the Piedmont region of North Carolina, and *B. callosa,* from the northeastern portion of West Virginia. The former is represented by the entire life history, the latter by the nymphal stage alone.

* Contribution from the Limnological Laboratory, Cornell University.

II. BÆTISCA CAROLINA

A. NYMPH

(1) HABITAT

The nymph of *B. carolina* was taken at two different stations in Guilford County, North Carolina. The first of these stations is one division of the outlet or overflow of an artificial pond, locally known as Hamburg Lake, and situated on the south branch of Reedy Fork River, eleven miles north of the city of Greensboro. The flow of water in that part from which the nymphs were taken is not constant, varying with the lake level, since it is not the main overflow. It is sometimes almost dry for a day or two at a time. The nymphs, however, were found in a round plunge-pool beneath the roots of a tree, water here varying from a few inches near the edge to nearly two feet in the deeper portions. The nymphs were seen swimming across the pool after some small stones in the shallow portion had been disturbed. One was taken on March 31, 1929, the other on April 5. Both were females, one much darker than the other. Repeated search in this pool and in all other branches of the overflow failed to yield any more nymphs, nor were any found during the remainder of the season of 1929 nor the season of 1930. The nymph caught March 31 transformed the forenoon of April 12, having undergone no moult since its capture. The second nymph from this station, which was likewise mature when captured, emerged April 22.

The second station for this species is the southern branch of Big Alamance Creek, fourteen miles south of Greensboro, at the extreme southern part of Guilford County. Here the flow of water is relatively constant, as Big Alamance is a fair-sized stream even in dry weather. The only two places in this stream where the nymphs have been found are directly above and a short distance below a ford leading to an old house known as Tom's Place. The bed of the stream is much the same in each place, being composed of loose gravel and sand near the quiet edge of the stream, areas of somewhat larger pebbles and small rocks in the center of the main current, and along one shore but also in the current many good-sized rocks. Nymphs could be collected here only by the use of the hand-screen and rake, as

repeated efforts to locate them by "hand-picking" the rocks and pebbles failed to yield a single one. However, the screen and rake used in the area just searched by "hand-picking," often yielded several nymphs. They were always found in the current.

During the season of 1929, only seven nymphs were found here, all of these being taken on April 13. Not a single nymph could be found on April 21, nor any cast skins. Three of these nymphs were males, one of which died as a nymph, the other two failing to transform from the subimago stage. One female nymph died, the others became imagoes. The dates of their transformations from the nymphal state are April 22 and May 1. In 1930, twenty-five nymphs were collected from this station on March 23. The season being much earlier than that of 1929, it was not surprising to find that many of these already showed the darkened wing-pads characteristic of the mature nymph. Seven of these were male, of which only three successfully attained to the imago state. Several of the twenty-five were killed and preserved, a few others died, the remainder transformed to imagoes from April 12 to April 15 inclusive. A period of very hot weather, with official temperatures ranging from 93° to 97°, occurred during these four days, and the *Bœtiscas* transformed very rapidly—five on April 12, five more on April 13, nine on April 14, the remaining nymph on the following day.

The extreme localization of these nymphs is worthy of note. While the principal streams of a considerable portion of the piedmont and also of the mountain areas of the state of North Carolina have been quite thoroughly worked for mayflies, and some collecting done in the tidewater region, in none of these except at the two stations mentioned have the *Bœtisca* nymphs been found. Not even in other parts of the same branches of Reedy Fork and Big Alamance, nor in their other branches, nor in streams closely adjacent, have any nymphs been taken.

(2) HABITS

Although the nymphs normally live in flowing water, little difficulty was experienced in rearing them indoors in standing water, which was changed daily. Nor did tap water prove injurious to them. On being brought in from their native habitat,

they were kept at first in stream water; in a day or two, stream water to which was added a small percent of tap water was used, the percent of tap water being increased daily, until soon only tap water was used. The mortality among the nymphs was quite low, even in hot weather. They were kept in glass culture dishes, the covers of which had been removed. These dishes were then placed on the sill of an open screened window, so that a constant current of air passed over them.

The nymphs brought in during the season of 1929 were not supplied with food, but were given two rocks and a stick upon which to crawl. During the 1930 season however, stones from their native stream, well coated with lower forms of plant life, were provided, and the nymphs were often observed feeding on these plants, eating off the growth up to the water line.

Both in feeding and swimming, they were more active in the evening. During the day they usually rested on the under sides of the stones, often however leaving one stone, swimming about for a time and bumping into the edge of the dish repeatedly, before coming to rest beneath another stone. Toward evening, more were seen on the upper surfaces of the stones, climbing up as high as the water line. But when a light was flashed on them suddenly, away they all scurried to the dark shelter of the under surfaces.

In collecting, if other species such as those of *Ephemerella* or *Heptagenia* were put in the same jar with *Bætisca* nymphs, the former soon collected in clumps on the backs of the *Bætiscas*, which at once endeavored to shake off the "climbers." Sometimes a *Bætisca* would be turned over on its back or side by such a group of nymphs of other species, and have some difficulty in righting itself. While on the stones in their dish, however, with only other *Bætiscas* present, one frequently clambered over the back of another, with little annoyance being evidenced by the one climbed upon. Also if a large nymph came to rest on the bottom of the dish, several smaller ones often congregated upon it, the larger making no attempt to shake them off.

When at rest, it was quite characteristic for the last three abdominal segments to be bent upward and the setae held up over the body, reminding the observer of a squirrel. The nymphs

walked or crawled rather slowly, but swam quickly in spurts, usually in a straight line, vibrating the setae rapidly. The legs were used little if any in the actual process of swimming. The body of the insect did not undulate as it swam, but rather it forged straight on like a tiny steamboat. Periods of several minutes' rest between spurts of swimming were not unusual. Nymphs clung rather tightly to their stones, and some slight force had to be exerted to remove one. When a stone with nymphs clinging to it was lifted from the water, some of the nymphs let go their hold and swam off at once, while others could be lifted out of the water readily, still on the stone.

Before the transformation to the subimago state, these nymphs became quite or entirely quiescent for a period of from twenty-four to forty-eight hours. Most nymphs retired to the sheltered lower surface of one of the stones to undergo this period of quiescence, but one nymph clung tightly to a small stick on the bottom of the dish. Frequent observations over a period of forty-eight hours failed to reveal any change of its position on the stick. Variations in size and color pattern among the nymphs made it possible to keep some one nymph under observation over a period of time, especially when it was quiescent. It was also possible to determine which nymphs were mature by the relative darkness of the wing-pads, even before the quiescent period.

B. SUBIMAGO

When ready to emerge from the water, some nymphs swam or crawled restlessly about for several minutes, others clambered directly up on the stone under which they had undergone their period of rest. Up they crawled, to and above the water line, continuing their journey to the highest point of the rock. Settling themselves securely and holding firmly with all their claws, they sat motionless. Soon the mesonotal hood began to split along the mid-dorsal line, and the subimago was slowly pushed out of its nymphal skin by the intermittent contractions of the abdomen. The wings were then pulled from the hood, and a quick flip caused them to unfold and expand. The subimago, freeing now its legs and setæ, rested a moment before

giving a quick flutter of the wings and alighting a short distance from the now-empty nymphal skin. Often the subimagoes remained for fifteen or twenty minutes on the rim of the glass dish, before attaining the window screen with a second quick flutter. Here they sat, moving only occasionally, until captured.

The subimagoes were placed in glass fruit jars. A piece of cloth on the floor of the jar provided foothold for any that fell from above. A twig placed inside the jar was a support upon which many climbed and remained during the entire subimago stage. Others preferred to cling to the sides of the jar, or to the coarsely-woven cloth over the top. During the very hot weather of 1930, the mortality among them was at first very high. The subimagoes were utterly unable to finish their transformation, due apparently to too dry an atmosphere. To counteract this condition, leaves and stems of some succulent plant were put in each jar and replaced by fresh ones every few hours. *Claytonia virginica,* being at hand, was used principally for this purpose. The subimagoes then behaved more normally, and the percent of mortality decreased sharply.

The length of the subimago stage varied directly with the temperature. In 1929, during a period of cold weather, one female remained in this stage for fifty hours. In 1930 during the period of extreme heat, the length of this stage of the insect's life was much shorter, varying from twenty-one to twenty-four hours. The following tabulation gives a more complete record of the life period of the subimago. The first two records are of specimens taken at Hamburg Lake. All the others are from Big Alamance Creek.

C. IMAGO

A fanning movement of the wings, which were gradually lowered parallel to the main axis of the body; a bulging of the head and thorax from the sudden rent in the subimago skin; quick and repeated contractions of the abdomen, and the subimago stage was at an end. The imago was pushed forth as was the subimago from the nymph skin, like a mummy from its shroud. Hanging now head down, the body aided by gravity in its escape from the enveloping cuticle, the imago first freed its legs, righted

SEX	EMERGENCE FROM NYMPH SKIN	FINAL TRANSFORMATION	TOTAL
♀	Apl. 22, '29—9–12 A. M.	Apl. 23—3–5: 30 P. M.	27–30 hrs.
♀	Apl. 22, '29—9–12 A. M.	Apl. 24—1: 45 P. M.	49–52
♂	Apl. 14, '30—8 A. M.	Apl. 15—6: 30 A. M.	22½
♂	Apl. 14, '30—8: 30 A. M.	Apl. 15—8: 15 A. M.	23¾
♂	Apl. 13, '30—8: 45 A. M.	Apl. 14—7 A. M.	22¼
♂	Apl. 13, '30—9: 55 A. M.	Apl. 14—8 A. M.	22
♀	Apl. 12, '30—9: 30 A. M.	Apl. 13—8 A. M.	22½
♀	Apl. 13, '30—10: 10 A. M.	Apl. 14—7: 30 A. M.	22⅓
♀	Apl. 13, '30—10: 15 A. M.	Apl. 14—8: 15 A. M.	22
♀	Apl. 14, '30—8: 30 A. M.	Apl. 15—8: 25 A. M.	24
♀	Apl. 14, '30—8: 35 A. M.	Apl. 15—7 A. M.	22½
♀	Apl. 14, '30—9: 10 A. M.	Apl. 15—7: 25 A. M.	22¼
♀	Apl. 14, '30—9: 15–10 A.M.	Apl. 15—8: 15 A. M.	22¼–23
♀	Apl. 14, '30—11: 10 A. M.	Apl. 15—8: 45 A. M.	21½
♀	Apl. 14, '30—11: 25 A. M.	Apl. 15—8: 20 A. M.	21
♀	Apl. 14, '30—12: 10 P. M.	Apl. 15—9: 20 A. M.	21⅙
♀	Apl. 15, '30—10: 00 A. M.	Apl. 16—7 A. M.	21

itself with a quick jerk, grasped the nearest support and pulled free the wings, abdomen and setæ. The newly-emerged imago rested but an instant, then with a sharp rustling sound from the rapidly-moving wings, flew to another part of the jar. It was active now for the remainder of its life.

Bætisca carolina new species

Measurements				
	Body	Tails	Wing	Foreleg
Male nymph (6 specimens)	7 – 9 mm.	1½–2 mm.		
Female nymph (13 specimens)	8 –10	1½–2½		
Male subimago (6 specimens)	6½– 9	3 –4½	9½–10½	3½–4½
Female subimago (4 specimens)	9 – 9½	4 –4½	11 –12	3½–4
Male imago (3 specimens)	8½–10	5½–7	9	7½–8⅜
Female imago (9 specimens)	8 –10½	4 –7	9½–11½	3½–4½

NYMPH (Pl. V, Figs. 1, 3, 4, 9, 11, 18. Pl. VI, Figs. 24, 25, 26, 28B, 30.)

Large nymph, lacking dorsal spines on mesonotal shield, and with prominent black spot on each side of abdominal tergite 6. Lateral spines on mesonotal shield not exceeding ½ mm.; amber tinted, tipped with dark brown or black. Definite carina on each side of this shield, another along mid-dorsal line. Entire body very finely granulose, hairy. In addition, larger brown papillæ or granulations occur in patches on head, thorax, ventral side of femora of legs, and abdomen (except venter of last two segments). These granulations especially numerous on ventral side of body. Color variation considerable, without regard to sex or age. In living nymphs, this variation ranges from yellow sand-color faintly marked with light brown, through intermediate greenish forms with definite darker color pattern, to very dark brown on which the markings are less prominent. All fully-mature nymphs show darkening of the mesonotal shield over the wings. Frontal processes on head not apparent.

HEAD—Projections of genæ amber, tipped with brown or black. Basal segment of antenna faintly brown, three distal segments dark brown, remainder yellowish. Location of lateral ocelli indicated by yellowish ellipse surrounded by brown granulations. Compound eyes black, margined with brown; yellowish area around each. Genæ fringed with hairs. Vertex and occiput irregularly mottled with brown, brown areas more extensive in dark forms. Mouthparts darker, with parts of labrum, tips of mandibles and ligula of labium reddish brown. Labium and mandibles ventrally with numerous brown papillæ. Maxilla with prominent projecting angle on inner margin opposite palp; a definite outward-curving arch in middle of outer margin. Tufts of hairs near middle of both outer and inner margin of maxilla. Maxillary palp equals galea-lacinia in length. Joints of maxillary palp (basal to distal) are to each other as 9½; 10½: 11. Labium as in *B. obesa.*

THORAX—Mesonotal shield, in light forms, sand-yellow with bars and irregular markings of light brown, and a few dark brown papillæ. In dark forms, the yellow background is almost obscured by thickly-set dark-brown papillæ scattered among brown markings. Saddle-shaped area between wing-roots remains lighter than other portions, in dark forms. Width of mesonotal shield, from tip to tip of lateral spines, 5½ mm. ventral margin of shield yellow to light brown, marked with brown in dark forms. Ventral aspect of thorax, in light forms, yellow marked with brown. On each pleura, a cluster of dark-brown papillæ above and anterior to each leg. Similar group in center of prosternum. Brown band with papillæ across anterior half of mesosternum, and on its posterior border two pyramidal forward-projecting brown areas on each side mid-ventral line. Anterior half of metasternum dark brown. In dark forms, back-ground of thoracic sternites dark brown, with yellow area bordering mesonotal shield. Yellow horizontal bar on each sternum between second and third pairs of legs, and two round yellow spots on upper metasternum.

LEGS—Ventrally, patch of brown granulations on femur. In dark forms, dark band across center of femur ventrally. In all forms, dark patch on outer margin of tibia at femoral joining, another on outer margin of tarsus near middle. Joining of claw to tarsus, and tips of claw, dark brown. Legs hairy. Claw long and slender, sharp-pointed. Claw almost equals tibia. First leg, tarsus = 2 1/10 length of tibia; second leg, tarsus = 1 4/5 length of tibia; third leg, tarsus = 1 2/5 length of tibia.

ABDOMEN—Tergites 1–5 concealed beneath mesonotal shield. Segment very wide; yellow dorsally in light forms, light brown in dark forms. Erect projection into which posterior margin of mesonotal shield fits tipped with dark brown. Edges of its four carinas light brown. Large irregular dark brown spot in center of depressed area on each side. Two dark brown bars on posterior lateral angles, parallel to posterior margin. Posterior surface of this projection thickly set with rather long hairs. Lateral margins of abdominal segments 6–9 much as in *B. obesa,* but with extensions of posterior lateral angles less sharply acuminate. In this respect, intermediate between *B. callosa* and *Bætisca* nymph in Cornell collection. Tergites 7–9 in all forms yellow, with three to five prominent marks on each. Brown streak on anterior portion of mid-dorsal line. Irregular hour-glass-shaped marks on each side, slanting obliquely toward center; and in dark forms, another dark bar parallel to this mark, between it and pleural fold. Tergite 10 yellow; in light forms, unmarked; in dark forms, mid-dorsal line brown. Sternites 1–6 dark brown, in dark forms, marked with yellow. Sternite 1 (thoracic) yellow posteriorly. 2–6 completely margined with yellow, this margin widest at mid-ventral line. Round spot on each side of each of these sternites, near pleural fold. Sternites 7–9 yellow with irregular dark brown area in center, this area having on each side three projecting lobes, and an oblong yellow spot in center. 7–8 margined posteriorly with brown. Lateral projections of 9, and genital appendages, amber yellow. In light forms, sternites yellow with brown markings. 2–5 each with narrow brown central band, at each end of which is large dark brown spot almost enclosing a yellow area. 6–8 with same brown central band, also few brown granulations in posterior half of each. Ends of central band two-forked, on 6–8, not as in 2–5. 9 with horizontal dark mark in center on anterior border, another longer mark parallel to it a short distance back from anterior border. Appendages as in dark form.

SETÆ—Equal in length and thickness, tapering distally. Light amber-brown, somewhat darker toward tip. Fringed on both sides with rather long hairs, except at basal portion, which is almost bare.

Described from two nymphs taken in Big Alamance Creek, N. C., Mch. 23, 1930.

MALE SUBIMAGO (Pl. VI, Fig. 27.)

General color of body russet brown, the russet tinge most prominent on abdominal tergites 6–10 and on mesonotum. *Head* dark brown. Com-

pound eyes grey; antennæ brown. Posterior projection of mesonotum bordered widely with dark brown; sutures dark brown. *Abdomen*—tergites 1–5, and sternites of same, light tan. Sternites 6–9 with brown patches bordering pleural fold. Wings spotted and marked with very dark brown, the dark areas more extensive than in *B. obesa* (see also figure in Needham). Base of fore wing and entire hind wing with definite orange flush. *Legs* greenish tan, first and second pairs with tarsus darker than other joints. Claws and all joinings dark brown. *Setæ* light tan, darker at base.

FEMALE SUBIMAGO

General color of body purplish brown. Head as in male. Thorax and basal segments of abdomen darker than in male. Mesonotum very dark brown streaked widely with grey, except posterior projection, which has two yellow streaks. Abdomen with definite purplish tinge. Tergites 4–9, and sternites 7–9, with light markings on some specimens, while others have no such markings ventrally, but same brown patches as in male. Segment 10 light tan. Legs very similar to male, but in some specimens first pair are darker brown than other two. Wings as in male. Setæ light tan on some specimens, dark brown on others.

Subimagoes described from several specimens taken as nymphs in Big Alamance Creek on Mch. 23, 1930, which transformed Apl. 12 and 13, 1930.

MALE IMAGO (Pl. VI, Figs. 19, 20.)

Body stout, tapering posteriorly from sixth abdominal segment. Mesonotum greatly enlarged, prolonged posteriorly into a backward-projecting process which covers the metathorax dorsally and extends to the second abdominal segment. The fold or membrane extending backward from center of metathorax, and continuous on each side with the axillary cord, quite prominent, orange in color, and covering first abdominal segment. Mesosternum greatly developed, its anterior division two-lobed anteriorly, divided only between the lobes. Metasternum reduced to small horizontal bar lying directly anterior to first abdominal sternite, which is thoracic. Sixth abdominal segment widest, approximately equal to any two of 2–4; seventh next in width. Seventh, eighth and ninth wider ventrally than dorsally. 5, 8 and 9 approximately equal in width, as are also, 2, 3, 4 and 10. 1 is distally very narrow, wide as 5 ventrally. Penis lobes closely appressed on inner margin, tapering distally. Seminal ducts open separately, in pouch-like structures near tip of each lobe, at point where each begins to taper. Basal segment of tarsus fused with tibia, except in foreleg.

HEAD—Vertex and occiput light tan. Central carina and mouth region brown. Ocelli and antennæ yellowish white. Compound eyes grey margined with white.

THORAX—Pronotum light tan, Mesonotum with greenish tinge, definitely lighter in color than pronotum or pleura. Posterior prolongation of mesonotum tipped and margined with black, its sutures light tan. Pleura light brown, sutures slightly darker. Sternal plates yellowish tan, except anterior division of mesosternum, which is brown.

THORACIC APPENDAGES

LEGS—Greenish white. Tips of claws and basal edge of each tarsal segment, also joinings of all other segments, pale brown. Foreleg little shorter than body. In one specimen, femur of foreleg measured 2.3 mm.; tibia, 1.9 mm.; tarsus, 4.7 mm. Tarsal segments of foreleg range in length from one to five, in this order.

WINGS—Translucent, slightly iridescent. In fore wing, basal one-third of all principal longitudinal veins orange-brown, this color especially prominent in costa, subcosta and radius. In life, entire basal portion of wing flushed with orange (in alcohol, this color fades). Remaining longitudinal veins brown. Cross veins very faint, except those from third anal to inner margin. Large cell on inner margin next to wing base, deep orange. Hind wing orange-tinted throughout, the coloration deeper at the base, very faint on outer margin. Longitudinal veins, intercalaries and cross veins in upper half of wing brown; other cross veins faint.

ABDOMEN—Pleural fold purplish brown. Tergites 1–5, same color, anterior half of each darker than posterior. On each side, near pleural fold, an oblique darker mark, two such marks on tergite 5. Tergite 6 also purplish brown. Small projection in center of this tergite dark purplish-brown, ridges leading from it of same color. Small dark spot surrounded by lighter area on each side near mid-dorsal line, on anterior border. On each side near pleural fold, three or four small dark dots. Tergites 7, 8, 9, and 10 brownish, showing but faint purplish tinge. Of these, all but 10 with yellow flush. Sternites 1–6 light tan, faintly purple-tinged (except 1). Round brown dots on 2–5, brown dash on 6, on each side near pleural fold. On 2, short brown mark on each side mid-ventral line halfway to pleural fold. On 2–5, horizontal brown dash on anterior margin, in same position. Sternite 6 irregularly mottled with brown. 7, light brown, with brown dash near pleural fold. 8 and 9 whitish or light yellow.

FORCEPS—White or yellowish, brown at tip.

PENIS LOBES—Whitish, brown-tipped.

SETÆ—White, slightly brownish near base. Joinings in proximal half of seta very light tan. Setæ with fine hairs throughout entire length. Rudimentary median seta brownish.

Holotype—♂; reared from nymph taken in Big Alamance Creek, N. C., April 15, 1930. Cornell University collection, No. 1000.1.

FEMALE IMAGO—Head as in male. Thorax as in male, except that pleuræ are lighter in color. Wings as in male. Legs same coloration as male; in one specimen, femur of first leg measured 1.5 mm.; tibia, 0.9 mm.; tarsus, 1.7 mm. Tarsal joints, in order of length, 5, 1, 2, 3, 4.

ABDOMEN—Entire abdomen tinged with pinkish-orange (due to presence of eggs); this color most prominent on tergites. Purplish brown tinge on pleural fold and oblique marks near to it, of tergites 2–4. Oblique marks of same color on tergite five, one-third distance from pleural fold to mid-dorsal line. Very narrow posterior border of same on tergites and sternites of 1–5. Small hump on tergite 6 (less prominent than in male) and lines radiating from it, also purplish. Round black spot near pleural fold on sternites 2–5. Tergites 9 and 10 yellow faintly flushed with pink. Pinkish-orange band, bordered by narrow band of creamy white, extends along mid-ventral line from anterior border of second sternite to posterior border of sixth. (In some specimens, may extend to sternite 9. On some also, a lavender line borders the orange band, between it and the white, on 2–5.) Position of oviducts on 6 and 7 indicated by creamy white line. Sternites 8 and 9 creamy white, except that some specimens have orange marks in form of triangle with base directed anteriorly, at anterior margin of 8. Rudimentary median seta yellowish tan; lateral setæ creamy white.

Allotype—♀; reared from nymph taken in Big Alamance Creek, N. C. April 13, 1930. Cornell University collection, No. 1000.2.

Paratypes—2 ♂s, Big Alamance Creek, N. C. April 13, 1930. Cornell Collection, Nos. 1000.3 and 1000.4.

8 ♀s, same station, May 1, 1929, and April 13, 1930. Cornell Collection, Nos. 1000.5–1000.12.

III. BÆTISCA CALLOSA

HABITAT AND HABITS

Prof. James G. Needham, who collected these nymphs from West Virginia, gives the following account of their habitat.

"These nymphs were first collected on August 18th, 1930, in Johnny Cake Run, near Mt. Storm, W. Va. This run is a small stream tributary to Abram's Creek, which later joins the north branch of the Potomac River. All the specimens found that day were in a short stretch of riffle about midway between U. S. Highway Route 50 and the mouth of the run. The stream was low, with only a few inches depth of water flowing among the small stones and gravel, and the land round about was open pasture.

"About thirty nymphs were taken on screens held in the current. Hand picking from the stones obtained only one nymph. Apparently they let go their footing when the stones are lifted from the water.

"The nymphs are very hard shelled. In water they feign death for a time when disturbed, folding the legs closely beneath the body and laying the tail forward over the back. Thus they become very unlifelike, and are hardly discoverable among the bits of gravel, which their colors simulate. When placed in water they quickly resume activity, swimming slowly and laboriously by very rapid vertical lashings of the very short tail.

"The first specimen was found by Mr. P. N. Musgrave. The others were found by the various members of the W. Va. summer zoological expedition. I found only six of them myself in more than an hour of diligent searching. They were not so common as were other mayflies, such as *Heptagenia, Chirotonetes,* and *Leptophlebia,* or stoneflies such as *Pteronarcys, Perla,* and *Leuctra.*

"Later single specimens were found at three other points in this same (N. Branch of the Potomac) drainage, at New Creek, and Patterson Creek eastward, and at Buffalo Run near Kingwood, W. Va."

Bætisca callosa new species

	Measurements	
	Body	Setæ
Nymph (6 specimens, immature)	3½–4½ mm.	½–1 mm.

(Pl. V, Figs. 6, 8, 10, 12, 14, 15, 17. Pl. VI, Figs. 21, 22, 23, 28C, 31.)

NYMPH—Small nymph, lacking both dorsal and lateral spines on mesonotal shield, and with prominent black band across basal portion of setæ. Very short frontal processes.

General color grayish white to light tan dorsally, venter dark except last two segments which are white. Mesonotal shield lacking both dorsal and lateral spines, its lateral margin bearing only an obtusely rounded projection. Definite carina along mid-dorsal line of this shield, likewise a carina on each side as in *B. carolina.* Entire body finely granulose, with

patches of larger papilla-like granulations on venter (except last three segments), ventral surfaces of femora, mesonotal shield and sparingly on head. Color variation considerable.

HEAD—Projections of genae rounded at tip, not ending in spines; light grey or white. Mouthparts and ocelli dark brown. Basal portion of antennæ light brown; distal portion dark brown. Compound eyes black, bounded by light area. Vertex, occiput and genæ varying from grayish white to light tan. Two more or less distinct patches of brown granulations on occiput on its posterior margin. Labrum twice as wide as long. Maxillary palps as in *B. obesa*,—shorter than galea-lacinia. Tufts of hairs on inner margin of maxilla only. Joints of maxillary palps are to each other as 9: 10: 12. (basal to distal). Mandible more deeply serrate on outer border than in *B. carolina;* many large granular papillæ on basal portion, which is also very dark in color. Basal joint of labial palp considerably wider in proportion to length than in *B. obesa* or *B. carolina.*

THORAX—Mesonotal shield grayish white, irregularly marked with numerous dark-brown granulations. These brown patches more evident on saddle-shaped portion between wing-roots and near posterior border. Lateral margins of shield grayish white, marked with brown on anterior half. Posterior margin dark brown, slightly hairy. Ventral surface of thorax, light brown. Ventral margin of shield gray with brown marks. In some of the darker forms among the paratypes, the mesonotal shield dorsally is light tan, ventral surface of thorax dark brown, and ventral margin of shield light brown margined with gray.

LEGS—Coxa, trochanter and femur dark brown banded with white near each joint. Tibia and tarsus grayish white, each with a transverse central dark brown band. Claw grayish, in shape long and slender. Claw exceeds tibia in first and second leg, almost equals it in third leg. First leg, femur equals tibia plus tarsus; tarsus equals $1\frac{4}{5}$ of tibia. Second leg, femur equals tibia plus tarsus; tarsus equals $1\frac{7}{8}$ of tibia. Third leg, femur equal to $\frac{9}{10}$ of tibia plus tarsus; tarsus equal to $1\frac{3}{5}$ of tibia. In some of the darker paratypes, tibia and tarsus light brown, claw amber.

ABDOMEN—Dorsally, segment 6 brown on posterior margin and in depression on each side of erect carina. Remainder of this segment white, carina the same. Segments 7–9, white, each with brown streak on anterior portion of mid-dorsal line. Dark brown spot on each side, near pleural fold. On 7 and 8, few scattered dark brown spots on each side, more numerous on 7. In some of the paratypes, these are arranged in an oblique line from margin to center Tergite 10 white, with two faint brown dots on each side near mid-dorsal line. These are lacking, on some of the paratypes. Sternites of abdomen light brown, to 8th. Sternite 8 white, with few small dark brown dots. Sternite 9 white, also marked with brown near anterior margin. In some of the paratypes, abdominal sternites 1 to 8 dark brown, sternite 8 likewise brown.

SETÆ—Equal in length and thickness, tapering distally. Basal one-third of each very dark brown to black. Distal portion yellowish white, well fringed with hairs.

Holotype—Nymph taken by Prof. James G. Needham in Johnny Cake Run, West Virginia, August 18, 1930. Cornell University Collection, No. 1001.1.

Paratypes—Six nymphs, same collector, same date and place. Cornell Collection, No. 1001.2–1001.7.

IV. BÆTISCA NYMPH FROM SACANDAGA RIVER, N. Y.

A nymph in the Cornell University collection, taken in the Sacandaga River by Mr. C. P. Alexander, has the following characteristics which distinguish it from *Bætisca obesa*, *B. carolina* and *B. callosa*.

Measurements

	Body	Setæ
Nymph (1 specimen, mature)	8 mm.	2½ mm.

(Pl. V, figs. 2, 5, 7, 13, 16. Pl. VI, figs. 28A, 29, 32, 33, 34.)

NYMPH—Large reddish brown nymph, lacking frontal processes on head, its median caudal seta neither as long nor as stout as the lateral ones.

HEAD—Neither frontal processes nor projections of genæ prominent. (Head had been removed and mounted previous to the date of these observations. On this mounted head, neither frontal processes nor projections of genæ are visible.) Labrum twice as wide as long. Maxilla and maxillary palp as in *B. obesa*. Joints of this palp are to each other as 7 : 8; 8 (basal to distal). Outer margin of right mandible curving gently upward to canines, greatest curve above center. Mandible thus appears to be thrust forward rather than being erect. Outer margin of left mandible curving gradually out at one-third distance from base, greatest curve above the center. Thus appears to be thrust upward and backward. Labium as in *B. obesa*.

THORAX—Mesonotal shield with dorsal and lateral spines, as in *B. obesa.* Lateral spine 1 mm. in length; yellow, not tipped with black. Width of shield from tip to tip of lateral spines, $5\frac{1}{4}$ mm. Mid-dorsal carina only faintly indicated. Posterior margin of shield set with short hairs. General color reddish brown with darker markings. Saddle-shaped portion lighter than rest of shield. Venter of thorax light tan, more or less thickly marked with reddish brown. No indications of large papilla-like granulations.

LEGS—Yellowish brown. Small dark spot at inner margin of femoro-tibial joint. Tarsus with four slightly oblique streaks extending from outer margin halfway to middle of segment, and dark spot near base of claw. Tip of claw brown, basal portion almost white. Claw proportionately shorter and stouter than in *B. carolina* or *B. callosa.* First leg, femur equals twice tibia; tarsus equals 1 of tibia; claw almost equal to tibia. Second leg, femur equals twice tibia; tarsus 1 of tibia; claw almost equals tibia. Third leg, femur little less than twice tibia; tarsus 1 of tibia; claw of tibia.

ABDOMEN—Dorsal aspect, general color reddish brown. Lateral margins of abdominal segments 6 to 9 as in *B. obesa.* Margin of erect carina on tergite 6 set with short hairs. Definite darker color pattern on each side of tergites 7–9. Entire venter light tan with reddish brown markings.

SETÆ—Lateral setæ stout at base, tapering distally. Median seta much less stout, also tapering; not equal in length to the laterals. All three well fringed with hairs in distal half of length. Later setæ reddish, median seta yellowish red.

V. KEY TO NYMPHS

1. Mesonotal shield with well-developed spines.
   Posterior angles of lateral margins on abdominal segments 6–9 ending in spines or spinous processes .... 2.
   Mesonotal shield lacking spines.
   Posterior angles of lateral margins on abdominal segments 6–9 obtuse, without spinous processes .... *B. callosa.*
2. Both dorsal and lateral spines present.
   Maxillary palp shorter than galea-lacinia .... 3.
   Only lateral spines present.
   Maxillary palp equal to galea-lacinia .... *B. carolina.*

3. **Head with prominent frontal projections.**
   Setæ equal in length and thickness . . .. *B. obesa.*
   Head without prominent frontal projections.
   Median seta not equal to laterals in length or thickness.
   ***B.*-nymph from Sacandaga River.**

VI. Consideration of Generic Characters.

Due to the fact that the characters of the genus were drawn up by Walsh from the single known species, *Bætisca obesa,* it now becomes necessary to modify them slightly. The following nymphal characters should be reduced from generic to specific rank :—

1. setæ of equal length and thickness (not true of specimen from Sacandaga River).
2. maxillary palp shorter than galea-lacinia (not true of *B. carolina*).
3. presence of both dorsal and lateral spines on mesonotal shield (not true of *B. carolina* or *B. callosa*).
4. presence of tubercles at wing-roots (not true of *B. carolina* and *B. callosa*).
5. tarsus about $1\frac{1}{2}$ as long as tibia (in *B. carolina,* more than twice as long in fore leg).
6. presence of frontal projections on head (not true of nymph from Sacandaga River).

The remaining nymphal characters as given by Walsh and Eaton still hold good. To them, however, might well be added :—outer canines of mandible, three; inner canines, two.

The generic characters of the adult which must now be reduced to specific rank are :—

1. penis-lobes unarmed, apparently combined into a single acute ovate lamellar intromittent organ, concave above and terminating with a single seminal pore (not true of *B. carolina*).
2. probably also the measurements for proportional lengths of abdominal segments 3–10 of female; as given by Eaton, from a dried specimen, these do not correspond with *B. carolina,* alcoholic specimen.

Other characters stand as given by Walsh and Eaton. To them could be added, however :—posterior margin of 10th abdominal segment of female bifid ventrally.

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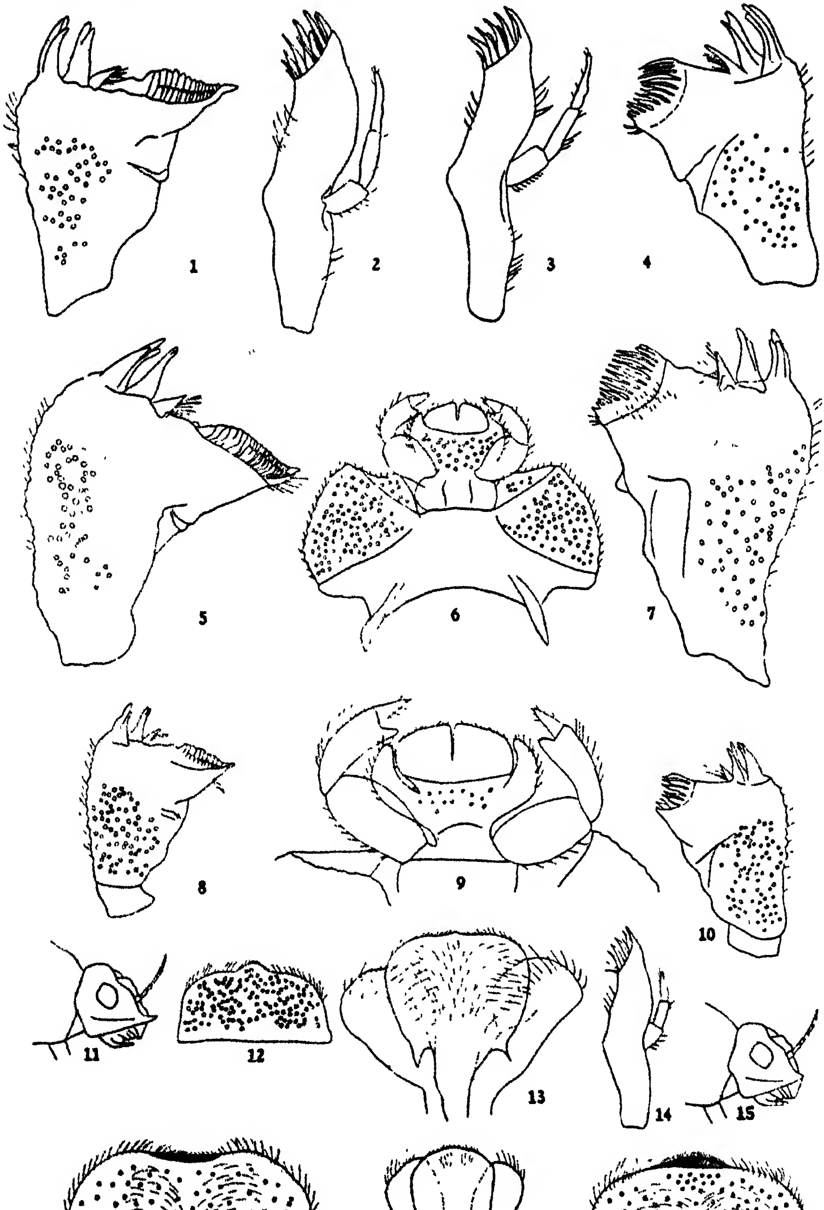
PLATE V

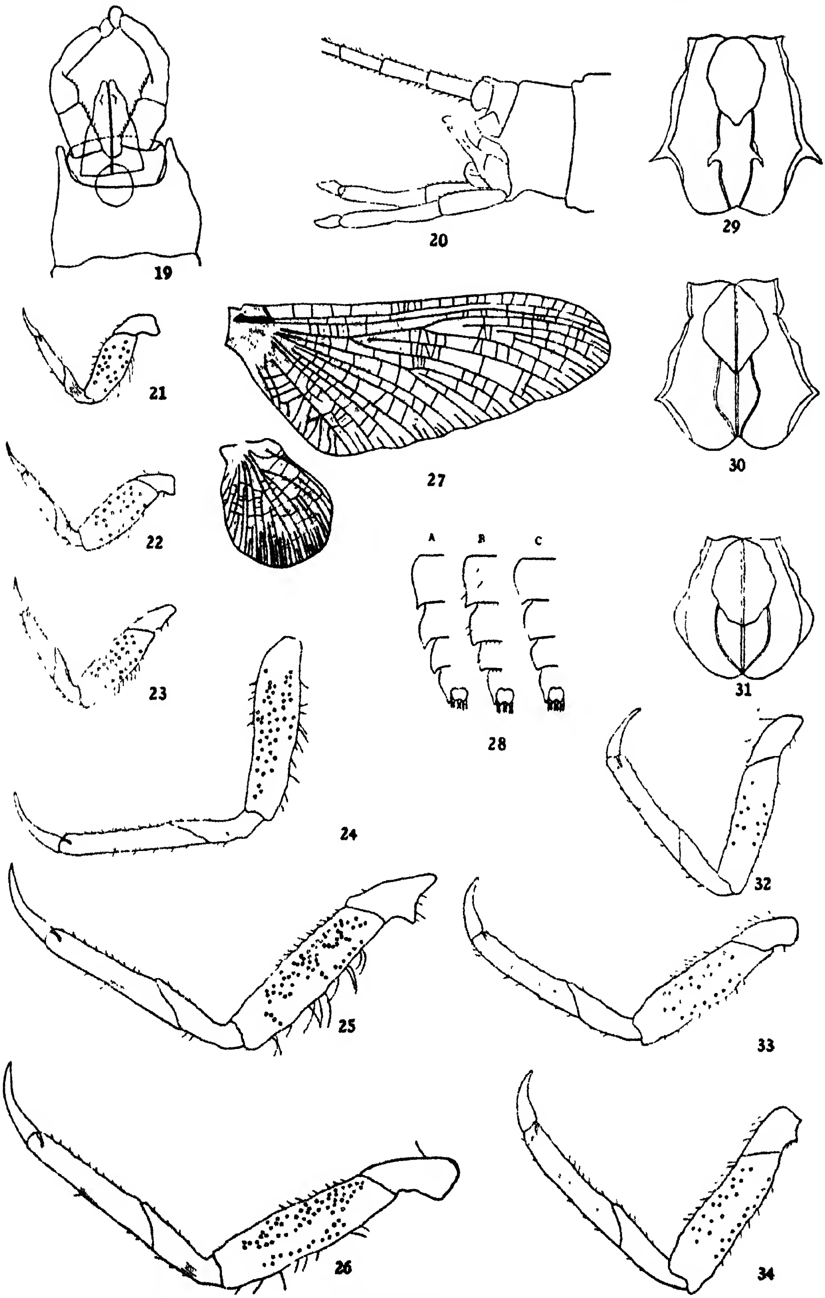
Figures 1 and 4. Right and left mandibles of *Bætisca carolina.*
Figure 2. Left maxilla of *Bætisca* sp? from Sacandaga River.
Figure 3. Left maxilla of *Bætisca carolina.*
Figures 5 and 7. Right and left mandibles of *Bætisca* sp? from Sacandaga River.
Figure 6. Labium of *Bætisca callosa.*
Figures 8 and 10. Right and left mandibles of *Bætisca callosa.*
Figure 9. Ligula and labial palps of *Bætisca carolina.*
Figure 11. Head of nymph of *Bætisca carolina,* side view.
Figure 12. Labrum of *Bætisca callosa.*
Figure 13. Hypopharynx of *Bætisca* sp? from Sacandaga R.
Figure 14. Left maxilla of *Bætisca callosa.*
Figure 15. Head of nymph of *Bætisca callosa,* side view.
Figure 16. Labrum of *Bætisca* sp? from Sacandaga River.
Figure 17. Hypopharynx of *Bætisca callosa.*
Figure 18. Labrum of *Bætisca carolina.*



BÆTISCA

PLATE VI.

Figure 19. Male genitalia, *Bætisca carolina*, ventral aspect.
Figure 20. Male genitalia, *Bætisca carolina*, side view.
Figures 21–23. 1st, 2nd and 3rd legs of nymph of *Bætisca callosa*.
Figures 24–26. 1st, 2nd and 3rd legs of nymph of *Bætisca carolina*.
Figure 27. Wings of male subimago, *Bætisca carolina*.
Figure 28. Lateral margins of abdominal segments 6–9 of nymphs:
A. *Bætisca* sp? from Sacandaga River.
B. *Bætisca carolina*.
C. *Bætisca callosa*.
Figure 29. Mesonotal shield, nymph of *Bætisca* sp? from Sacandaga River.
Figure 30. Mesonotal shield of nymph of *Bætisca carolina*.
Figure 31. Mesonotal shield of nymph of *Bætisca callosa*.
Figures 32–34. 1st, 2nd and 3rd legs of nymph of *Bætisca* sp? from Sacandaga River.



BÆTISCA

NOTES ON THE DIOPTIDÆ (LEPIDOPTERA)

BY WM. T. M. FORBES

The two recent papers on the Dioptidæ, Prout's generic revision[1] and Hering's illustrated review,[2] together make a monograph of the family, and for the first time make a complete arrangement possible. The following notes are largely based on material in the Cornell University collection, and in the U. S. National Museum, now containing the very rich Dognin collection.

Scotura. I think the number of species will have to be largely reduced in the *fulviceps* group. This is a wide-spread species, with both maculate and immaculate forms in at least part of its range, as well as local variation. As I see it *fulviceps* Felder and *distincta* Hering, of the Amazon, which we took together, are forms of the same Amazonian race, while the case is similar with *intermedia* and *nigreta* Warr. and *abstracta* Prout, which represent the Guiana race. The types of *nervosa* Schs. were from Venezuela.

The female of *Euchontha frigida* Wlk. (*sublactigera*) seems to remain a mystery. Our 1920 expedition caught a series of males, but as usual without a single female. Yet the species is not really rare, and it seems as if the female even if dimorphic, should have been described. On the assumption that it would be probably some mimetic form, and without the special venational characters of the male, I sought through the females of the family and found only one with the characteristic apical spot on the hind wing, *Myonia citrina*. Unfortunately that is certainly the female of *capena*. We have a male of *clareta* Warr., and as the type is really a female, this gives one clue to the behavior of the genus. In this case the special venation has disappeared in the female, which would go well enough in Tithraustes. The pattern is not unlike in the sexes, but our male has the grayish hind wing shown in the Seitz figure (69 i 7).

[1] Novitates Zoologicae 25, 395; 27, 508.

[2] Seitz's "Macrolepidoptera of the World" vol. 6, 501 ff., with plates 68–71.

Dioptis and Josia. We have no guide as yet through these complicated genera, so the following keys, though incomplete and artificial, may be of some use. In the case of Dioptis I assume that there were three transverse bands across the wing in the archetype, any two of which may actually appear: 1, a median across the whole height of the cell and then directly across to the tip of Cu_2, before the anal angle; 2, a postmedial, from at or near the upper angle of the cell, diverging out, and usually leaving some transparent spots between itself and the lower angle of the cell, then running to near the fork of M_3 and Cu_1, turning a sharp angle, and when complete running parallel to the outer margin, to the inner margin; 3, a subterminal band across the apex. In interpreting the pattern, brown counts as black, rather than as white.

1. Fore wing with a complete medial black band,[3] running the whole height of the end of the cell, and then to the inner margin at and before the end of cell Cu_2; postmedial band, when present, nearly straight.
   2. Median and postmedial bands similar, entirely separate and parallel, the latter less than a third way from the end of cell to apex. **peregrina.**
   2. Postmedial band, when present fused with medial at costa, and usually for the whole height of the cell, then diverging from it and running to the outer margin along Cu_1, leaving an elongate transparent space in cell Cu_1.
      3. A subterminal band nearly half way between end of cell and apex, visible at least below, the apex sometimes largely suffused with black above.
         4. Postmedial band appearing as an outer fork of the median, running obliquely across from the medial to the subterminal and covering Cu_1
            5. Hind wing tawny.... ... . **æliana**
            5. Hind wing with tawny submarginal stripe only. **dentistriga**
            5. Hing wing without tawny or orange above **onega**
         4. No heavy black bar or shade covering subterminal portion of M_3 and Cu_1, or at most such a bar about half as heavy as that on Cu_2, in dark specimens.
            5. Markings wholly black, the border of the hind wing when broad, extending in a triangle to the fork of M_3–Cu_1 **phelina, areolata, restricta, columbiana**[4]

[3] In some specimens of phelina the median band is reduced to a faint and irregular shade, but there is no postmedial band, only a subterminal in its usual position, and filling cell M_3.

[4] D. onega of Hering seems to be an aberration of phelina, but is I believe incorrectly identified. The forms of phelina which I have seen can be

5. Hind wing with a broad even border, containing a tawny stripe
   6. A tawny spot at anal angle of fore wing above **roraima**
   6. No tawny spot at anal angle of fore wing, a postmedial tawny costal spot, visible below, and almost always above **cyma**
   6. No tawny on fore wing; an even tawny border on hind wing above and below
      7. White areas at end of cell and subapically, both cut by black veins **trailii**
      7. White apical spot solid, the postmedial one cut by the black veins **angustifacia**
      7. Both white areas solid white, not cut by dark veins **leucothyris**

3. Apex broadly black half way in to end of cell, without a separate subterminal band
   4. Postmedial band present as a heavy black bar obliquely across Cu_1 from lower angle of cell to lower end of the black (or partly tawny) apical area, enclosing a long oval transparent spot in cell Cu_1; black streak in cell of fore wing confined to its upper portion
      pallene (not of Hering) ♂, **egla** ♀, **phædima** ♀, **climax** ?
   4. Cu_1 without a thickened black line, typically white
      5. Black filling of cell confined to its upper portion, the lower part transparent
         ilerdina (*opaca* of Hering), **tessmanni**, **charon** (*pallene* of Hering), **curvifascia** Prt., **egla** Hering, not Dr., **zarza** Dgn.
      5. Black filling of cell covering its lower portion, leaving a slender transparent strip along R
         meon, **nigrivenia** (*ilerdina* Hering, not Bates)

1. Median band absent, there being no black connection between lower angle of cell and inner margin at tip of Cu_2; postmedial band well developed, practically always leaving some transparent spots beyond lower angle of cell, typically angulate at the fork of M_3 and Cu_1, and continued, but often very faintly, to inner margin near anal angle
   2. Postmedial band of even width, angulate, but not touching either cell or outer margin . . **indentata**
   2. Postmedial band touching upper angle of cell, or connected to it by blackish suffusion, running directly across to outer margin, then faintly if at all continued to inner margin

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separated as follows; I have seen no columbiana, and only ♀ restricta:

a. Apical patch solid white .. . . **phelina**
a. Veins in apical patch black
   b. Black stripes half as wide as the spaces between them . **restricta**
   b. Black stripes much wider . .. . **areolata**

3. Postmedial band reaching outer margin along M_3[5]
candelaria, pellucida, symoides, nivea
3. Postmedial band reaching outer margin at Cu_1
   4. Hind wing with tawny stripe in border
   cheledonis, uniguttata, incerta
   4. No tawny, the postmedial stripe ending broadly at tip of Cu_1, without a branch to inner margin cutting off a spot in tip of cell Cu_1 . . . . **charila**

In the majority of cases I believe the final groups are each composed of a single slightly variable species, and that the characters based on the tawny markings may also be of merely variational value. On the other hand the forms figured by Hering as *egla* and *zarza* seem distinct from anything for which we have a valid name.

I should put Hering's two species, *peregrina* and *indentata*, at the head of two main groups, as they show in a primitive way the two types of medial and postmedial bands; they are evidently related, and stand in contrast to all the others in the separate median and postmedial bands at the costa. A check-up of Seitz's figures with the original descriptions shows several misidentifications, which I have indicated, and there may be more among species unknown to me. The meon group, including the "*ilerdina*" of Seitz, contrasts with all the rest in the position of the black in the cell, and perhaps should be more completely isolated, but I believe it is an advanced rather than primitive form.

JOSIA

As in Dioptis the present key is merely a first attempt, and will doubtless need a good deal of revision. I believe there are not as many species as we list, the details of marking, and even the presence or absence of pattern on the hind wing being apparently of less than specific value. On the other hand the various patterns of the abdomen seem of real value.

1. Abdomen with middorsal and lateral pale (yellow) stripes
   2. Hind wing marked with white . . . . ***group dorsivitta***
   2. Hind wing marked with red . . . . ***group draconis***
1. Abdomen with dorsum wholly black, with lateral orange stripes or none
   2. Hind wing wholly black, fore wing with orange stripe oblique or transverse

[5] I believe all these names represent one species.

3. **Hind wing overcast with blue** . . . . **iliare**
3. **Hing wind dull black**
    4. **Transverse stripe of fore wing extending toward or to base just below costa** . . . . **fluonia**
    4. **Stripe simple, transverse** . . . . **ena** (*tryma*)
2. **Hind wing with orange or yellow markings, concolorous with those of fore wing**
    3. Fore wing with longitudinal basal and oblique subapical stripes. *group megæra*
    3. Fore wing with a single transverse stripe across apex
        4. Lemon yellow, even faintly greenish
            5. Stripe broad and rounded, hind wing with border as in eterusialis ... **flavissima**
            5. Stripe short and narrow, ending at fold **cercostis**
        4. Markings orange-yellow
            5. Fore wing with a broad stripe covering the fork of Cu_2 as well as M_3 and Cu_1 . **eterusialis**
            5. Fore wing with a narrow stripe, covering tip of cell and fork of M_3 and Cu_1 only
                6. Hind wing with a narrow black border, a quarter width of wing, the yellow extending to base **fornax**
                6. Hind wing with more black, its base black
                    7. Stripe of fore wing broad, extending well below A, and only linearly separated from inner margin, on hind wing small and cut off slightly beyond cell; under side of abdomen *white* **coatepeca**
                    7. Stripe of fore wing ending in a point on A, not resting on inner margin; under side of abdomen mainly or wholly concolorous blackish (*vittula*)
                        8. Stripe of hind wing broad and almost squarely cut off at fork of M_3 and Cu_1
                            9. Stripe 2/3 width of wing **angulosa** Wlk.
                            9. Stripe ½ width of wing **morena** Warr.
                        8. Stripe extending (as a blunt point above M_3) well beyond fork of M_3 and Cu_1 **vittula** Hbn., **constricta** Warr.
    3. Fore wing with a longitudinal stripe only
        4. Stripe of fore wing falling short of the outer margin by nearly 3 mm., hind wing with black border
            5. Stripe broad, at the end of the cell extending from above Rs to fold . . . . **gopala**
            5. Stripe narrow, extending from middle of cell to Cu_2 . **patula**
        4. Stripe of fore wing almost reaching outer margin
            5. Hind wing with a tawny costal stripe, covering most of Sc, and down to or even over R

6. Black medial stripe practically reaching base, and practically filling cell, or if limited to upper half of cell, with dorsal half of wing wholly tawny (*auriflua*)
  7. Stripe of fore wing crosses A only near base, mostly lying above it ... . **a. flavipars**
  7. Stripe running along vein A to middle of wing or further
    8. Hind wing with black solid on basal half to below fold; stripe of fore wing practically reaching margin
      9. Stripe of fore wing with its boundary running along A to 2/3, then abruptly leaving it; in the types with a small orange postmedial dash in radial region **a. a. form scalata**
      9. Stripe gradually diverging from A beyond middle; no costal stripe **a. auriflua**
    8. Black area of hind wing mostly bounded by Cu; strip of fore wing falling 1½ mm. short of margin ... **a. inæquiflexa**[6]
6. Black stripe limited to outer half of wing, or narrowly extending to base in forms which have a black wedge on inner margin (sometimes extended into a complete black border above, but then distinct below) (all these forms are from Ecuador and probably are not distinct)
  7. Black border of hind wing above broadly (1 mm.) connected with black costa .. **subcuneifera**
  7. Connection slender or absent **glycera, turgida, conifera**

5. Costa of hind wing below black except at base, the stripe extending to middle of cell, then tawny over Cu, but broadly black again over dorsal part of wing except on inner margin
  6. Adomen with a transverse tawny stripe on first segment
    7. Stripe on fore wing ½ width of wing, crossing M_3 and extending broadly across R . . .. . **cruciata**[7]
    7. Stripe on fore wing about 1/8 width of wing, lying wholly above stem of Cu and M_3 **annulata**[8]
  6. No transverse stripe on abdomen (a trace in *mononeura*)

[6] The forms of *auriflua* intergrade.

[7] As identified by Dognin.

[8] In *annulata,* the stripe at the base of the wing lies wholly above Cu, in the superficially similar *ligula*-forms it is mainly below Cu at the base.

7. Fore wing grayish, obviously paler than hind wing
   8. Stripe on Cu of fore wing linear, running out to near margin along M_2 **mononeura**
   8. Darker, stripe broader, and straight **insincera**
7. Ground of wings concolorous
   8. Abdomen wholly blackish, without side-stripes
      9. Stripe of fore wing deep, orange, lying mostly above Cu **aurimutua** (*fulvia*‡, *jesuita?*)
      9. Stripe yellow, covering most of the stem of Cu
         10. Stripe narrow and even, as in striata **attenuata**
         10. Stripe broad at ⅓ way out, tapering to outer margin, hind wing small **ampliflava** (part)
   8. Abdomen with a slender, normally interrupted white lateral stripe
      9. Stripe of fore wing of even width, at its widest 1/4 width of wing **striata**
      9. Stripe diamond-shaped, at the middle more than half width of wing **ampliflava** (part)
   8. Abdomen with broad orange lateral stripes
      9. Costal edge of fore wing wholly black
         10. Stripe of fore wing more than half width of wing, the black reduced to narrow borders **lativitta** (*oribia*)
         10. Stripe about ⅓ width of wing **ligula** (*fulvia*)
         10. Stripe about 1/6 to 1/8 width of wing
            11. Black touching cell where Cu_1 leaves it on both wings, the orange stripes very slender and somewhat suffused **interrupta**
            11. The part of Cu bordering the cell located wholly in the orange stripe in both wings **tenuivitta** (*identification?*)
      9. Costal edge noticeably tawny (*ligeta*)[9]
         10. Tawny area extended, on the upper side extending broadly to M_2; and practically filling the cell below (large species) . . **fusigera**

[9] The species with black body or only a narrow white stripe, have the yellow area of the hind wing much wider than on the fore wing, in the similar ligata forms the stripes are equal in width.

10. Tawny area not over ¼ width of wing
    11. Small, the size of ligula .... **ligata**
    11. Larger, the size of fusigera .. **gigantea**
10. Tawny stripe less than 1/6 width of wing; a small species ... . **frigida**[10]

[10] These ligata forms intergrade both in size and pattern, and I believe represent only one species.

A CASE OF STYLOPIZATION IN A PANURGID BEE, LIOPŒUM SUBMETALLICUM (SPINOLA)

BY HERBERT F. SCHWARZ

Although it has been known for some time that stylopization occurs in bees of the family Panurgidæ, relatively few instances have hitherto been reported. Pierce[1] (1904) made the following notation:

"While collecting bees about nine o'clock A. M. on Aug. 10, 1903, on the garden squash, Mr. J. C. Crawford, Jr., of West Point, Nebraska, took a species of *Panurginus*, in the body of which were two female *Xenos*, and in his collecting tube, flying frantically about, was a male *Xenos*. It had probably been in copula with one of the females when taken."

Later (1918) Pierce recognized this host as *Panurginus innuptus* Cockerell. In 1906, Friese[2] recorded four stylopized females of the panurgid genus *Halictoides*, collected at Innsbruck. An additional species—*Panurginus ornatipes* Cresson (*boylei* Cockerell) from Las Vegas, New Mexico—was listed by Pierce[3] in 1909. The number of known panurgid hosts was notably increased in 1910, when Robertson[4] recorded stylopization in four of his species of the genus *Pseudopanurgus*, namely, *labrosus*, *labrosiformis*, *rudbeckiæ*, and *solidaginis*—all collected at Carlinville, Illinois. In 1913, Morice[5] reported stylopization in a female and in a male of *Panurgus cavannæ* Gribodo that he had taken in the same locality, Jericho, ten years apart.

[1] "Some hypermetamorphic beetles and their hymenopterous hosts," by W. Dwight Pierce. Nebraska University Studies, 1904, Vol. IV, pp. 153–190, with 2 plates and 1 text figure.

[2] "Über die systematische Stellung der Strepsipteren," by H. Friese. Zoologischer Anzeiger, 1906, Vol. XXIX, pp. 737–740.

[3] "A monographic revision of the twisted winged insects comprising the order Strepsiptera Kirby," by W. Dwight Pierce. U. S. Nat. Mus. Bulletin 66, pp. 1–232, with 15 plates and a map, published 1909.

[4] "Hosts of Strepsiptera," by Charles Robertson. Canadian Entomologist, 1910, Vol. XLII, pp. 323–330.

[5] "A note concerning certain cases of stylopisation," by F. D. Morice, Entomologist's Monthly Mag., 2nd Ser., 1913, Vol. XXIV, pp. 253–254.

"In both these cases," Morice states, "the parasite is imbedded under the 4th abd. segment of the host. The ♂ has only one of them, the ♀ has two, but in neither case is any considerable distortion of the abdomen to be noticed."

Pierce[6] (1918) noted under the name *Panurginus boylei* Cockerell the specimen that he had previously (1909) listed as *Panurginus ornatipes* Cresson (*boylei* Cockerell)[7] and added to the known panurgid hosts yet another, *Panurginus californicus* Cresson from Los Angeles County, California. Salt[8] (1927) was able to enrich the records by a further species, *Pseudopanurgus æthiops* Cresson, from Wray, Colorado, and to note another example in a known host, *Panurginus innuptus* Cockerell, from Minot, North Dakota.

So far as I am aware, no instance of stylopization has hitherto been reported for the panurgid genus *Liopœum.* The stylopized specimen here considered is a male from Angol, Chile, collected Dec. 7, 1929, by D. S. Bullock. The parasite is deeply imbedded between the fourth and fifth tergites of its host. Another male specimen of the same species of *Liopœum,* taken in the same locality and by the same collector but on Nov. 19, 1926, is available for comparison, as are several females.

In the stylopized specimen the maculation of the lower half of the face is drastically reduced in contrast to the full expanse of pale yellow in the normal specimen. Only a trace of yellow remains in each of the lateral angles of the clypeus, the rest of the clypeus being entirely black. The lower half of the maculations on the sides of the face have been replaced by black. The mandibles, too, are black, but the labrum and a tripartite maculation just above the clypeus show only a slightly more limited extent of yellow than in the normal specimen. The front tibiæ,

6 "The comparative morphology of the order Strepsiptera, together with records and descriptions of insects," by W. Dwight Pierce. Proc. U. S. Nat. Mus., 1919, Vol. LIV, pp. 391–501, with 15 plates, 3 text figures, and map.

7 Swenk and Cockerell (1907) regarded *boylei* as a subspecies of *ornatipes.* "The bees of Nebraska," by Myron H. Swenk and T. D. A. Cockerell. Entomological News, 1907, Vol. XVIII, pp. 178–187.

8 "Notes on the Strepsiptera and their hymenopterous hosts," by George Salt. Psyche, 1927, Vol. XXXIV, pp. 182–192.

instead of being yellow as in the normal male, are black with merely a basal cream-colored spot, paralleling the condition of the female. The hind basitarsi are ferruginous like those of the female instead of dark as in the normal male. Another respect in which the stylopized male resembles the opposing sex rather than its own is in the presence, along the carination on the middle femora below, of a comb-like arrangement of microscopic bristles. Spinola (1851) in defining the genus *Camptopœum* (from which *Liopœum* was subsequently separated) mentions the presence of this brush or comb in the females and its absence in the males. Another peculiarity—but without parallel in normal individuals of either sex—is a dense, appressed matting of hair, similar in character and only a little less compact than the fasciæ along the apical margins of the tergites, that extends almost concealingly from base to apex over the left half (the half on which the parasite occurs) of tergites 5 and 6. The right half of tergites 5 and 6 is, as in the normal specimen, sparsely covered with erect, thin hairs. The sculpturing of the *Liopœum* seems to have been unaffected by the parasite and I have not been able to find any departure from the normal in the proportions of the segments of its antennæ, in the venation of its wings, etc.

I believe that the specimens above discussed belong to the species *Liopœum submetallicum* (Spinola) though they are perhaps to be considered a variety of that species. From Spinola's description the normal male differs scarcely at all but the females that I associate with the males have a tripartite band of yellow (much like that of the male) above the clypeus, a small cream-colored maculation at the base of the front and middle tibiæ (duplicated in the case of the first tibiæ of the stylopized male and in the case of the middle tibiæ of both the males), the scape dull orange beneath, and the fascia on tergite 1 broadly interrupted medianly.

A LIST OF HESPERIIDÆ FROM BARRO COLORADO ISLAND, CANAL ZONE, AND ADJACENT PANAMA, WITH A DESCRIPTION OF A NEW SPECIES

By E. L. Bell
Flushing, N. Y.

The species contained in the following list were collected by the writer during his visit to this region, from October 13 to 23, 1928, and by Mr. C. H. Curran, during the latter part of December 1928, January, and February 1929. A total of 129 species in 79 genera are recorded here; of these one species is described as new, and two species, of which only a single female of each was taken, remain unidentified, but are placed as nearly as possible in their respective genera.

Of the total above mentioned, 76 species in 49 genera were taken on Barro Colorado Island. At the time of the writer's visit to this locality, *Hesperiidæ* were abundant about the Station clearing, especially along the brook and jungle edge, in the banana grove, and on the flowers of the Hibiscus bushes in the rear of the clearing, and in the clearing at the tower on the Wheeler trail; very few, however, were found along the jungle trails; but Mr. Curran reports that during his visit, two to four months later, he found a good many along the trails. This difference is probably accounted for by the different seasons in which the visits were made.

Of the other localities where the writer collected, the banana grove and jungle edge at the rear of the grounds of the Plant Introduction Gardens at Summit, afforded good collecting as well as along the railroad track in the vicinity of the Gardens. At Pedro Miguel the collecting was entirely done on the Chiva Chiva trail. This trail is bordered by thickets and swamps and affords very good collecting. As the vegetation along the sides is very dense a long handled net is necessary when collecting along this trail. At Ft. Amador, the first quarter of a mile of the causeway to the fortified islands yielded very good results.

a few species being taken exclusively in this locality. Tapia Bridge, Panama, is located a little beyond Juan Diaz, and is about fifteen miles from Ancon; near the bridge, and along the roadside, were several flowering bushes which were very attractive to butterflies. All one needed to do, was to stand at one of these bushes and pick out the desirable species as they visited the flowers. The grassy places along the road, and many flowering weeds yielded good results. Old Panama City, Panama, was interesting from its historical associations, and would likely have yielded better collecting results had the vegetation not been recently cleared from the roadsides.

The nomenclature and sequence of the list closely follows that of the "Biologia Centrali-Americana." Where changes have been necessary, they are noted. The records of distribution are also mainly those of the Biologia, with additions from the collection of the writer, and elsewhere as noted.

The writer wishes to express here, his thanks and sincere appreciation of the many courtesies extended by Mr. and Mrs. James Zetek to Mrs. Bell and himself, which made their visit to the Canal Zone so pleasant and so successful.

Pyrrhopyge phidias Linnæus

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 22, 1928, 3 males, 1 female; Corozal, C. Z., Jan. 16, 1929, 2 males, Feb. 4, 1929, 1 male; Ft. Sherman, C. Z., Feb. 5, 1929, 1 male.

Usually found resting on the upper sides of leaves, especially those of a shiny surface, but occasionally on the under sides of the leaves; in either case they rested with the wings spread at right angles to the body. Sometimes they would dart out of the bushes and fly about the writer's head and the white net, seemingly attracted by the light color of the straw hat and the net; efforts to capture them when doing this were futile, as their flight was extremely rapid; when resting on the leaves they were easily captured.

Distribution: Panama to South Brazil; Trinidad (Kaye).

Pyrrhopyge erythrosticta Godman and Salvin

Barro Colorado Island, C. Z., Feb. 19, 1 male; Ft. Sherman, C. Z., Feb. 5, 1 male.

Although these specimens lack the red spot towards the base of the primaries, on the upper side, they have the narrower dark margin of the secondaries beneath, and it seems probable that they are merely a form, or perhaps race, of *erythrosticta.* The genitalia from one of these specimens does not differ in form from that of a specimen from Chiriqui, Panama, which has the red spots referred to.

Mysoria venezuelæ Scudder

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 22, 1928, 1 female.

This single individual was found resting on the upper side of a leaf, with outspread wings.

Distribution: Mexico to south Brazil; Trinidad (Kaye).

Goniurus simplicius Stoll

Tapia Bridge, Panama, Oct. 15, 1928, 1 male; Old Panama City, Panama, Oct. 16, 1928, 1 male; Patilla Pt., C. Z., Jan. 15, 1929, 1 male.

The *Biologia* uses the genus *Eudamus* for the tailed species, but it has been pointed out by Barnes and McDunnough, and Lindsey, (2) that *Eudamus* falls to *Goniurus. Simplicius* is a widely spread and common species, and the few specimens recorded here do not indicate that it was at all scarce in this region, but merely that they were taken for the record only.

Distribution: Texas and Arizona to south Brazil; Trinidad.

Goniurus eurycles Latreille

Barro Colorado Island, C. Z., Oct. 13, 1928, 1 female; Dec. 26, 1928, 1 male; Summit, C. Z., Oct. 17, 1928, 1 female; Corozal, C. Z., Jan. 16, 1929, 1 female.

This species somewhat resembles *simplicius;* flies with it over most of its distribution and the two are often confused; however, the male of *eurycles* lacks the costal fold found in the male of *simplicius* and there are differences in maculation which will readily separate most individuals. The species was in much greater abundance than these few records indicate.

Distribution: Mexico to Argentine; Trinidad. *Eurycles* has been recorded in the North American fauna, from along the Mexican border, but the record is, perhaps, somewhat doubtful.

Goniurus doryssus Swainson

Barro Colorado Island, C. Z., Feb. 19, 1929, 1 male.

Distribution: Mexico to south Brazil; Trinidad (Kaye, as *brachius*).

Goniurus carmelita Herrich-Schaffer

Corozal, C. Z., Jan. 9, 1929, 1 male; Ft. Randolph, C. Z., Feb. 6, 1929, 1 male.

These specimens seem to be a form or race of *carmelita* and allied to *nigrocauda* Godman and Salvin, but differ from the description of that insect in the number and position of the subapical spots of the primaries and in the exact extent of the white area of the fringes of the secondaries; that both of these characters are variable is illustrated in the two specimens and the Corozal specimen has a narrow spot near the base of interspace 3, which is lacking in the other one.

Distribution: Panama, Chiriqui, Colombia are recorded in the *Biologia* for *nigrocauda*. Draudt gives Brazil for *carmelita*.

Goniurus cenis Herrich-Schaffer

Old Panama City, Panama, Oct. 16, 1928, 1 female.

Distribution: Panama, Colombia, Venezuela.

Goniurus proteus Linnaeus

Barro Colorado Island, C. Z., Feb. 14, 1929, 1 female; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20, 1928, 1 male; Tapia Bridge, Panama, Oct. 15, 1928, 1 female.

Distribution: Southern United States to Argentine and in the Antilles.

Goniurus acawoios Williams

Barro Colorado Island, C. Z., Dec. 23, 1928, 3 males, Jan. 5, 1929, 1 male, Jan. 7, 1929, 1 male.

The form of the genitalia identifies these specimens as the Williams species. *Acawoios* resembles *proteus* but the primaries are somewhat narrower and more pointed at the apex, and these specimens are smaller than the general average of *proteus*. The species was described from British Guiana and is, of course, a new record for the Canal Zone.

Distribution: British Guiana, Panama.

Goniurus huancavillcas Williams

Tapia Bridge, Panama, Oct. 15, 1928, 1 female.

This may be a form of *proteus* Linnaeus, as suggested by Williams (1) in his description.

Distribution: Described from Ecuador.

Goniurus dorantes Stoll

Barro Colorado Island, C. Z., Feb. 16, 1929, 1 female; Patilla Pt., C. Z., Jan. 15, 1929, 1 female; Ft. Amador, C. Z., Oct. 23, 1928, 1 male, 1 female.

This species was also very abundant, the few mentioned here having been taken for the records only.

Distribution: Texas and Arizona south to Argentine; Antilles, in races.

Goniurus ceculus Herrich-Schaffer

Barro Colorado Island, C. Z., Jan. 6, 1929, 1 male.

According to Williams (1) this species was misidentified by Godman and Salvin, who placed it in synonymy with *auginus* Hewitson.

Chioides catillus Cramer

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20, 1928, 1 male, 1 female; Corozal, C. Z., Jan. 21, 1929, 1 male.

Lindsey (1) erected the genus *Chioides* with *albofasciatus* Hewitson as the type, and states that *catillus* and *albofasciatus* are closely related; also a very abundant species.

Distribution: Panama to Brazil; Trinidad.

Spathilepia clonius Cramer

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20–22, 1928, 3 males.

Distribution: Mexico to south Brazil; Trinidad.

Telegonus talus Cramer

Barro Colorado Island, C. Z., Dec. 23, 1928, 1 female.

Talus is recorded in the Biologia under the genus *Goniurus*, but Lindsey (2) has pointed out that it is the type of *Telegonus* as fixed by Butler.

Distribution: Mexico to Brazil; Cuba; Haiti; Porto Rico; Trinidad (Kaye).

Telegonus creteus Cramer

Barro Colorado Island, C. Z., Feb. 14, 1929, 1 male.

Distribution: Mexico to Brazil; Trinidad (Kaye, as *parmenides*).

Telegonus fulgerator Walch

Barro Colorado Island, C. Z., Dec. 23, 1928, 1 female, Jan. 12, 1929, 1 male.

Fulgerator is placed in the genus *Thymele* in the *Biologia*, but Williams (2) has united *Telegonus* and *Thymele*, disregarding the secondary sexual characteristics.

Distribution: Mexico to Brazil; Trinidad.

Telegonus egregius Butler

Barro Colorado Island, C. Z., Feb. 16, 1929, 1 male.

A rather small specimen, with a complete discal band on the primaries.

Distribution: Mexico to Colombia.

Telemiades amphion Hubner

Tapia Bridge, Panama, Oct 15, 1928, 1 male.

Distribution: Mexico to Brazil.

Bungalotis midas Cramer

Ft. Randolph, C. Z., Jan. 23, 1929, 1 male.

Distribution: Honduras to south Brazil: Trinidad (Kaye).

Cecropterus neis Geyer

Barro Colorado Island, C. Z., Jan. 12, 1929, 1 male, Feb. 14, 1929, 2 males, Oct. 13, 1928, 1 male; Corozal, C. Z., Feb. 1, 1929, 1 male; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20–22, 1928, 2 males, 1 female; Tapia Bridge, Panama, Oct. 15, 1928, 2 males; Old Panama City, Panama, Oct. 16, 1928, 1 female.

Distribution: Mexico to Brazil; Trinidad (Kaye).

Cecropterus aunus Fabricius

Barro Colorado Island, C. Z., Dec. 23, 1928, 1 female; Patilla Pt., C. Z., Jan. 15, 1929, 1 male; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20–22, 1928, 5 males, 2 females.

Distribution: Mexico to south Brazil; Trinidad.

Cogia calchas Herrich-Schaffer

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 16–20, 1928, 1 male; Tapia Bridge, Panama, Oct. 15, 1928, 2 males; Old Panama City, Panama, Oct. 16, 1928, 1 male; Ft. Amador, C. Z., Oct. 23, 1928, 1 male; Corozal, C. Z., Jan. 21, 1929, 1 female, Feb. 4, 1929, 2 males, 1 female.

An exceedingly abundant species. Females observed ovipositing on *Mimosa pudica*, the common "sensitive plant."

Distribution: Southern Texas to south Brazil; Trinidad.

Hydrænomia orcinus Felder

Barro Colorado Island, C. Z., Jan. 6, 1929, 1 female.

A single worn specimen was the only one taken.

Distribution: Mexico to south Brazil.

Lignyostola lacydus Druce

Barro Colorado Island, C. Z., Jan. 6, 1929, 1 male.

Distribution: Nicaragua to Peru.

Hyalothyrus neleus Linnaeus

Barro Colorado Island, C. Z., Jan. 6, 1929, 1 female.

Distribution: Nicaragua to Brazil.

Phanus vitreus Cramer

Barro Colorado Island, C. Z., Jan. 5, 1929, 1 male; Feb. 19, 1929, 1 male.

Distribution: Mexico to south Brazil; Trinidad.

Phanus marshalli Kirby

Corozal, C. Z., Feb. 1, 1929, 1 female.

The *Biologia* places *marshalli* as a synonym of *vitreus* Cramer.

Distribution: There are specimens from Guatemala; French Guiana; Dutch Guiana; Brazil; Trinidad, in the collection of the writer.

Entheus cramerianus Mabille

Corozal, C. Z., Jan. 19, 1929, 1 female.

The proper association of females in this genus, especially when unaccompanied by males, is often a difficult matter; this specimen, however, agrees with females of *cramerianus* in the collection of the writer. *Cramerianus* is placed in the Biologia in the synonymy of *peleus* Linnaeus.

Distribution: The *Biologia* records Panama to south Brazil for *peleus;* Draudt gives Guiana for *cramerianus.*

Quadrus cerialis Cramer

Barro Colorado Island, C. Z., Oct. 19, 1928, 1 female, Dec. 27, 1928, 1 male, Jan. 5, 1929, 1 male.

The genus *Pythonides* is used in the Biologia for *cerialis* and allied species, but Lindsey (2) points out that *Pythonides* must replace *Ate,* as the type is *jovianus* Cramer and erects the genus *Quadrus* to take the place of Pythonides auct.

Distribution: Mexico to south Brazil; Trinidad (Kaye).

Pellicia bromias Godman and Salvin

Corozal, C. Z., Jan. 22, 1929, 1 male.

Distribution: Mexico to Panama; Lindsey (3) adds Peru and Brazil.

Pellicia dimidiata Herrich-Schaffer

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20, 1928, 1 male; Tapia Bridge, Panama, Oct. 15, 1928, 1 female.

Recorded in the Biologia as *didia* Moschler, Draudt includes *didia* as a synonym of *dimidiata.*

Distribution: Mexico to Guiana; Trinidad.

Pellicia licisca Plotz

Tapia Bridge, Panama, Oct. 15, 1929, 3 males.

Godman and Salvin record as *thyestes,* which Draudt includes as a synonym of *licisca.*

Distribution: Mexico to Panama; Dr. Lindsey (3) adds Peru.

Mycteris cærulea Mabille

Barro Colorado Island, C. Z., Jan. 6, 1929, 1 female.

The single female is provisionally referred to this species.
Distribution: Guatemala to Columbia.

Echelatus semipternus Butler and Druce

Old Panama City, Panama, Oct. 16, 1928, 1 female.
Distribution: Mexico to Brazil.

Celænorrhinus eligius Cramer

Barro Colorado Island, C. Z., Feb. 19, 1929, 1 male; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 22, 1928, 1 male.
Distribution: Guatemala to Argentine; Trinidad.

Eudamidas ozema Butler

Tapia Bridge, Panama, Oct. 15, 1928, 1 male.
Distribution: Mexico to south Brazil.

Xenophanes tryxus Cramer

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 22, 1928, 1 male; Tapia Bridge, Panama, Oct. 15, 1928, 1 female.
Distribution: Texas to south Brazil; Trinidad.

Ouleus fridericus Geyer

Tapio Bridge, Panama, Oct. 15, 1928, 2 males; Summit, C. Z., Oct. 17, 1928, 1 male, 1 female; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20-22, 1928, 2 males.

Biologia records in genus *Achlyodes,* but Lindsey (2) points out that the type of that genus is *busirus* Cramer as fixed by Butler and proposes the genus *Ouleus* to replace *Achlyodes* Scudder, not Hubner, with *fridericus* as orthotype.
Distribution: Panama to Brazil; Trinidad.

Sostrata leucorrhoa Godman and Salvin

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20, 1928, 1 male.
The form of the genitalia of this specimen is identical with that of *Sostrata scintillans* Mabille as figured in the *Biologia.* I use the name *leucorrhoa* for this specimen, although it is included by Draudt in the synonymy of *adamas* Herrich-Schaffer.
Distribution: Panama; Colombia; Taboga Island; Trinidad.

Paches loxus Westwood, Doubleday and Hewitson

Barro Colorado Island, C. Z., Oct. 19, 1928, 2 males, Dec. 19, 1928, 1 male, Dec. 26, 1928, 1 male, Jan. 8, 1929, 1 male; Old Panama City, Panama, Oct. 16, 1928, 2 males; Corozal. C. Z., Jan. 22, 1929, 1 male.

Distribution: Mexico to south Brazil.

Paches subalbata Plotz

Old Panama City, Panama, Oct. 16, 1928, 1 female.

Only this single female taken. Godman and Salvin say that all the specimens known to them are females. This specimen was taken on the flowers of lantana in company with *loxus*, and it seems possible that *subalbata* may be merely a form of the female of that species.

Distribution: Panama to Venezuela.

Pythonides proxenus Godman and Salvin

Barro Colorado Island, C. Z., Dec. 28, 1928, 1 female.

Described in the *Biologia* in the genus *Ate*, but as remarked under *Quadrus*, Lindsey (2) points out that Butler cited *jovianus* as the type of *Pythonides* and Godman and Salvin cite *jovianus* as the type of *Ate*, therefor the two genera are identical and *Pythonides* has priority.

Distribution: Guatemala to Panama.

Pythonides amaryllis Staudinger

Tapia Bridge, Panama, Oct. 15, 1928, 1 female.

Distribution: Guatemala to Ecuador.

Eantis thraso Hubner

Barro Colorado Island, C. Z., Jan. 6, 1929, 1 female, Oct. 19, 1928, 1 male.

Distribution: Texas to Paraguay; Trinidad.

Antigonus nearchus Latreille

Barro Colorado Island, C. Z., Oct. 18, 1928, 1 male, Jan. 7, 1929, 1 male.

Distribution: Mexico to south Brazil; Trinidad.

Systasea erosus Hubner

Barro Colorado Island, C. Z., Oct. 19, 1928, 1 male; Summit, C. Z., Oct. 17, 1928, 1 male; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 22, 1928, 1 male; Tapia Bridge, Panama, Oct. 15, 1928, 1 female; Corozal, C. Z., Feb. 4, 1929, 3 males.

Distribution: Mexico to Paraguay; Trinidad.

Ebrietas undulatus Herrich-Schaffer

Corozal, C. Z., Feb. 4, 1929, 1 male.

This is recorded in the *Biologia* as *anacreon* Staudinger, but now considered as a synonym of *undulatus*.

Distribution: Mexico to south Brazil.

Camptopleura thrasybulus Fabricius

Tapia Bridge, Panama, Oct. 15, 1929, 1 male.

Distribution: Mexico to south Brazil; Trinidad (Kaye).

Helias palpalis Latreille

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20–22, 1928, 3 males; Tapia Bridge, Panama, Oct. 15, 1928, 1 female.

Distribution: Panama to Brazil.

Gorgythion begga Prittwitz

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20, 1928, 1 female.

Begga has the anal angle of the secondaries beneath more or less whitish and is often recorded as a form of *pyralina* Moschler, but as *begga* was described first, Prittwitz, Stett. Ent. Zeit., p. 198, 1868, it must hold the specific name; *pyralina* described by Moschler, Verh. z.-b. Ges Wein, p. 343, 1876, without the whitish anal angle area is a form of *begga* Prittwitz.

Distribution: Panama to Paraguay.

Anisochoria polysticta Mabille

Tapia Bridge, Panama, Oct. 15, 1928, 1 female; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 22, 1928, 2 females; Corozal, C. Z., Feb. 4, 1929, 1 male.

Distribution: Mexico to Guiana; Dr. Lindsey (3) adds Peru.

Staphylus cupreiceps Mabille

Tapia Bridge, Panama, Oct. 15, 1928, 4 males.

Distribution: Mexico to Brazil.

Staphylus aurocapilla Staudinger

Barro Colorado Island, C. Z., Oct. 18, 1928, 2 males, 1 female; Tapia Bridge, Panama, Oct. 15, 1928, 3 males, 2 females.

These specimens are referred to *aurocapilla* although they do not exactly agree with the *Biologia* figures, such slight differences as exist may be due to individual variation.

Distribution: Mexico to Argentine, Trinidad.

Staphylus mazans Reakirt

Barro Colorado Island, C. Z., Oct. 13–18–19, 1928, 3 males, 1 female; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20–22, 1928, 1 male. 2 females; Old Panama City, Panama, Oct. 16, 1928, 1 male; Tapia Bridge, Panama, Oct. 15, 1928, 1 male, 3 females.

The *Biologia* records as *ascalaphus* Staudinger, but in the Supplement sinks that name to *mazans* Reakirt.

Distribution: Texas to Venezuela; Trinidad; Dr. Lindsay (3) adds Peru.

Staphylus imbras Godman and Salvin

Barro Colorado Island, C. Z., Oct. 18, 1928, 1 male.

Distribution; Mexico to Panama.

Paramimus stigma Felder

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20–22, 1928, 3 males; Tapia Bridge, Panama, Oct. 15, 1928, 1 female; Corozal, C. Z., Jan. 21–22, 1929, 2 females; Patilla Pt., C. Z., Jan. 15, 1929, 1 female.

Distribution: Panama, Taboga Island, Colombia.

Heliopetes arsalte Linnaeus

Summit, C. Z., Oct. 17, 1928, 1 male; Ft. Amador, C. Z., Oct. 23, 1928, 1 male; Tapia Bridge, Panama, Oct. 15, 1928, 1 female; Corozal, C. Z., Jan. 19–21, 1929, 1 male, 1 female, Feb. 4, 1929, 1 male.

Some of these specimens show a tendency toward the form *petrus* Hubner as there is a more or less definite band of white spots included in the darkened apical area of the primaries.

Distribution: Mexico to Paraguay; Trinidad.

Heliopetes alana Reakirt

Barro Colorado Island, C. Z., Oct. 13, 1928, 1 male.

Distribution: Mexico to Paraguay.

Heliopetes macaira Reakirt

Corozal, C. Z., Feb. 4, 1929, 2 males.

Distribution: Arizona and Texas to Panama; Taboga Island.

Heliopetes nivella Mabille

Tapia Bridge, Panama, Oct. 15, 1928, 2 males; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20, 1928, 1 female.

Distribution: Texas to Brazil.

Pyrgus orcus Cramer

Barro Colorado Island, C. Z., Oct. 13, 1928, 5 males, 1 female, Dec. 30, 1928, 1 female; Summit, C. Z., Oct. 17, 1928, 1 female; Tapia Bridge, Panama, Oct. 15, 1928, 1 male, 1 female; Patilla Pt., C. Z., Jan. 15, 1929, 5 males.

Placed in the genus *Hesperia* in the *Biologia;* Lindsey (4) fixes *Pyrgus* in place of *Hesperia* auct. *Orcus* is placed by authors as a synonym of *syrichtus* Fabricius, but it is apparently distinct. It is also the *syrichtides* of Reverdin.

Distribution: The writer's records of the distribution of *orcus* do not show any localities north of the Canal Zone, but extend from there over practically the whole of South America, and in Dominica; St. Lucia (Amer. Mus. of Nat. History); Trinidad; Margarita Island.

Pyrgus notata Blanch

Tapia Bridge, Panama, Oct. 15, 1928, 2 males, 2 females; Old Panama City, Panama, Oct. 16, 1928, 1 female.

Distribution: Mexico to Argentine.

Erynnis gesta Herrich-Schaffer

Ft. Amador, C. Z., Oct. 23, 1928, 1 female; Tapia Bridge, Panama, Oct. 15, 1928, 1 male.

Recorded in the *Biologia* in the genus *Chiomara;* Lindsey (1) removes it to *Thanaos,* and Barnes and Benjamin in their List of Diurnal Lepidoptera, Bull. So. Calif. Acad. of Sciences, xxv, part 1, 1926, replace *Thanaos* with *Erynnis.*

Distribution: Mexico to south Brazil; Jamaica; Texas and Arizona.

Apaustus menes Cramer

Barro Colorado Island, C. Z., Oct. 13–18, 1928, 2 males; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 22, 1928, 1 female.

Distribution: Panama to Brazil.

Ancyloxypha xanthina Mabille

Tapia Bridge, Panama, Oct. 15, 1928, 3 males, 2 females.

These specimens very well agree with Mabille's description of *xanthina* from Valera (Venezuela?) in regard to the maculation, and long wings and palpal third joint, but they do not seem to belong in the genus *Ancyloxypha;* perhaps the identification may not be correct. They were found only in this one place, a grassy opening along the edge of a swampy thicket; they flew low in among the grasses and weeds and visited the yellow flowers of a small weed, and when they rested on these they were very inconspicuous; the flight is very similar to that of *Ancyloxypha numitor* Fabricius. From their resemblance to *Zariaspes mys* Hubner, it is probable that they have been mistaken for that species in collections.

Chærephon citrus Mabille

Ft. Amador, C. Z., Oct. 23, 1928, 7 males, 19 females.

This species was very abundant at the beginning of the causeway to the fortified islands, but was not taken in any other locality visited.

Distribution: Mexico to Panama.

Hylephila phylæus Drury

Summit, C. Z., Oct. 17, 1928, 1 female; Ft. Amador, C. Z., Oct. 23, 1928, 1 male, 3 females; Ft. Randolph, C. Z., Feb. 6, 1929, 1 male.

Distribution: Connecticut to Pacific coast, south through Central and South America to Argentine; Antilles.

Polites vibex Geyer

Ft. Amador, C. Z., Oct. 23, 1928, 4 males, 3 females; Corozal, C. Z., Feb. 4, 1929, 1 male.

Recorded in the *Biologia* under the genus *Thymelicus*.

Distribution: New Mexico and Texas through Central and South America to Argentine; Trinidad.

Polites athenion Hubner

Barro Colorado Island, C. Z., Oct. 13–14, 1928, 3 males, Dec. 29, 1928, 1 female; Ft. Amador, C Z., Oct. 23, 1928, 2 males, 2 females; Summit, C. Z., Oct. 17, 1928, 2 females; Tapia Bridge, Panama, Oct. 15, 1928, 1 male; Ft. Randolph, C. Z., Jan. 23, 1929, 1 male; Corozal, C. Z., Jan. 16, 1929, 1 male, Jan. 19, 1929, 1 male, Feb. 4, 1929, 1 male, 2 females.

Recorded in the *Biologia* in the genus *Thymelicus*. Everywhere the writer collected in the Canal Zone, this species was very abundant.

Distribution: Mexico to Brazil; Trinidad.

Zariaspes mys Hubner

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20, 1928. 1 male.

Only this single specimen taken.

Distribution: Mexico to Paraguay.

Atrytone species?

Ft. Randolph, C. Z., Feb. 6, 1929, 1 female.

This specimen seems very close to *Atrytone gladiolis* Dyar, from British Guiana, differing in having less fulvous areas on the wings and not so brightly fulvous on the head and thorax; it may be a dark form of that species. There is a similar unidentified female in the collection of the National Museum.

Calpodes ethlius Cramer

Ft. Amador, C. Z., Oct. 23, 1928, 2 males.

Distribution: Southern United States to Argentine; Antilles.

Prenes sylvicola race fusina Hewitson

Barro Colorado Island, C. Z., Jan. 21, 1929, 1 female.

Recorded in the *Biologia* as a synonym of *Prenes nero* Fabricius. *Fusina* may be a synonym of *sylvicola* Herrich-Schaffer but the writer prefers to retain it for this specimen.

Distribution: There are specimens in the collection of the writer from Dutch Guiana, Bolivia. Argentine and Brazil, as *fusina*.

Prenes ocola Edwards

Barro Colorado Island, C. Z., Feb. 15, 1929, 1 male.

Distribution: Southern United States; Mexico; Central America; South America to Peru; Trinidad. In the "New York State List of Insects" it is recorded by Davis as having been taken on Staten Island, N. Y., by Capt. R. D. Wainwright.

Prenes vala Mabille

Barro Colorado Island, C. Z., Oct. 13, 1928, 1 female; Tapia Bridge, Panama, Oct. 15, 1928, 1 male.

Distribution: Mexico to Brazil.

Aides dysoni Godman

Barro Colorado Island, C. Z., Oct. 18–19, 1928, 5 males, 3 females; Ft. Randolph, C. Z., Jan. 23, 1929, 1 male.

This species was described from a single female from Honduras, in the collection of the British Museum. One of the females closely agrees with the *Biologia* figure; the other two have additional silvery spots on the under surface of the secondaries, illustrating the variability of this character; the males associated with these females have the silvery spots much enlarged and coalescent, forming one very large spot; the stigma is very prominent and formed as in *elara*, the description of which follows that of *dysoni*. All of the Barro Colorado specimens were taken on the flowers of the Hibiscus bushes back of the laboratory, and were usually present in some numbers,

early in the day; they are very swift fliers and dart away with great rapidity when disturbed.

Distribution: Honduras; Panama.

Xeniades pteras Godman

Barro Colorado Island, C. Z., Oct. 18–19, 1928, 2 males.

Also taken on the Hibiscus flowers in company with *dysoni*.

Distribution: Panama to Venezuela.

Vaccera litana Hewitson

Barro Colorado Island, C. Z., Feb. 14, 1929, 1 male.

Distribution: Mexico to Amazons; Trinidad.

Vaccera egla Hewitson

Barro Colorado Island, C. Z., Oct. 13, 1928, 1 male, Dec. 26, 1928, 1 male.

Distribution: Mexico to Panama.

Rhinthon cynea Hewitson

Barro Colorado Island, C. Z., Dec. 29, 1928, 1 male, Jan. 8–12, 1929, 4 males.

Distribution: Mexico to Venezuela.

Rhinthon megalops Godman

Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 22, 1928, 1 female.

Distribution: Mexico to Panama.

Cobalus cannæ Herrich-Schaffer

Barro Colorado Island, C. Z., Jan. 6, 1929, 1 female.

Distribution: Mexico to Argentine.

Cobalus fidicula Hewitson

Barro Colorado Island, C. Z., Dec. 29, 1928, 1 female.

This specimen is referred to *fidicula* as it agrees with male specimens, except that it lacks the white spot near the margin of the secondaries above, but is present beneath. It is the only female specimen seen by the writer.

Distribution: Honduras to Panama.

Cobalus viribius Cramer

Barro Colorado Island, C. Z., Jan. 5–6, 1929, 1 male, 1 female, Feb. 16, 1929, 1 male; Corozal, C. Z., Jan. 19, 1929, 1 male.

The *Biologia* does not record this species from the Central American region.

Distribution: Panama to Brazil.

Cobalopsis pelora Plotz

Barro Colorado Island, C. Z., Feb. 14, 1929, 1 male.

Recorded in the *Biologia* as *edda* Mabille, which Draudt includes as a synonym of *pelora,* and which is followed here, perhaps not correctly, as Godman says in his notes on the Plotz species "Probably not the female of *Cobalopsis edda* Mab., as suggested in the Biologia."

Distribution: The *Biologia* gives Mexico to Guiana for *edda;* there are specimens in the collection of the writer from Colombia, Ecuador and Trinidad; Plotz described *pelora* from Brazil.

Morys valerius Moschler

Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 22, 1928, 1 male.

Distribution: Mexico to Brazil.

Perimeles remus Fabricius

Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 20–22, 1928, 1 male, 2 females; Summit, C. Z., Oct. 17, 1928, 2 males; Tapia Bridge, Panama, Oct. 15, 1928, 1 male.

Distribution: Mexico to Brazil.

Tigasis zalates Godman

Barro Colorado Island, C. Z., Feb. 16, 1929, 1 male.

The identification of this specimen is probably correct, but the genitalia have not been examined.

Distribution: Costa Rica to Panama.

Euroto compta Butler

Barro Colorado Island, C. Z., Oct. 18, 1928, 2 males, 1 female, Dec. 22, 1928, 1 male, Jan. 8–10, 1929, 1 male, 1 female; Tapia Bridge, Panama, Oct. 15, 1928, 1 female.

Distribution: Panama to Brazil; Trinidad (Kaye).

Euroto micythus Godman

Tapia Bridge, Panama, Oct. 15, 1928, 2 males.

The *Biologia* records it from Mexico, Costa Rica; Taboga Island, British Guiana, Peru and Brazil are added by Lindsey (3); in the collection of the writer from Trinidad.

Lerema accius Abbot and Smith

Barro Colorado Island, C. Z., Oct. 19, 1928, 1 female; Tapia Bridge, Panama, Oct. 15, 1928, 1 female; Summit, C. Z., Oct. 17, 1928, 1 male; Pedro Miguel, C. Z., Oct. 20–22, 1928, 2 males; Ft. Amador, C. Z., Oct. 23, 1928, 3 males.

These specimens lack the variegated appearance on the underside that is found in North American specimens, but the form of the male genitalia is the same.

Distribution: Southern United States to Brazil.

Metron chrysogastra Butler

Barro Colorado Island, C. Z., Jan. 7, 1929, 1 male; Corozal, C. Z., Feb. 4, 1929, 2 males.

This is usually spelled "*chrysogaster*" but the original spelling is as above.

Distribution: Mexico to Amazons; Trinidad.

Metiscus atheas Godman

Barro Colorado Island, C. Z., Oct. 13, 1928, 1 male.

Distribution: Mexico to Amazons; Trinidad.

Thargella fuliginosa Godman

Barro Colorado Island, C. Z., Jan. 8, 1929, 1 male, Jan. 21, 1929, 1 male, Dec. 26, 1928, 1 female.

Distribution: Nicaragua to Amazons; Trinidad (Kaye).

Mnasitheus simplicissimus Herrich-Schaffer

Barro Colorado Island, C. Z., Dec. 26, 1928, 1 male, Feb. 19, 1929, 1 male; Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 22, 1928, 2 males, 1 female; Summit, C. Z., Oct. 17, 1928, 1 male.

Distribution: Mexico to Brazil; Trinidad.

Mnasitheus zeteki new species, (Fig. 1, male genitalia)

Above. Primaries: immaculate blackish brown, darkened toward the base; veins a little darker than the ground color.

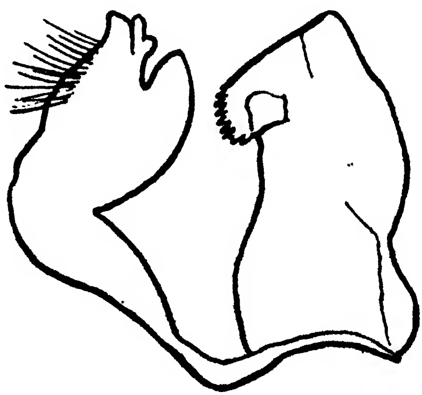
Secondaries: same as the primaries, the costal margin paler than the rest of the wing.

Beneath. Primaries: costal margin and apical area purplish-brown, becoming decidedly purplish at the apex; in and just below the cell, blackish; from vein 2 to the inner margin paler.

Secondaries: purple, except the abdominal fold which is brown.

Thorax and abdomen, above and beneath dark brown. Head, above and beneath, dark brown, with a slight greenish reflection between the antennæ. Palpi, above dark brown, beneath somewhat paler. Legs concolorous with the body. Antennæ a little longer than the cell, with moderate club, apiculus about twice the diameter of the club; black above and beneath, the club paler beneath. Eyes dark brown. Fringes, of primaries above, yellowish-brown at anal angle, growing darker toward the apex; of secondaries, yellowish-brown; beneath, of primaries, brown, darker than the ground color of the wings; of the secondaries, yellowish-brown, a little darker than above. Expanse: 36 mm. (center of thorax ×2)

The stigma is indistinct, except under a lense, and consists of a narrow line beneath vein 2, extending from its base for a little more than two millimeters and another line above vein 1 about four millimeters in length, directly below the upper one.



Described from one male, Barro Colorado Island, C. Z., Oct. 18, 1928; type in collection of the American Museum of Natural History, New York City.

It is with pleasure that this species is named for Mr. James Zetek, of Ancon, Canal Zone.

The stigma corresponds to the form of that of *chrysophrys* Mabille, from Colombia, mentioned by Godman in the *Biologia,*

in a footnote on page 566, but *zeteki* is a much larger and differently colored insect than the description of *chrysophrys* indicates for that species.

Mnasilus penicillatus Godman

Corozal, C. Z., Feb. 4, 1929, 1 female; Patilla Pt., C. Z., Jan. 15, 1929, 1 female.

Distribution: Mexico to Brazil; Trinidad.

Vehilius illudens Mabille

Barro Colorado Island, C. Z., 3 males, 2 females; Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 22, 1928, 3 males, 1 female; Summit, C. Z., Oct. 17, 1928, 4 males, 2 females; Old Panama City, Panama, Oct. 16, 1928, 1 female; Tapia Bridge, Panama, Oct. 15, 1928, 2 males.

An inconspicuous, but very abundant species. The pale, diffuse, discal area of the secondaries beneath varies considerably; in some specimens it is entirely lacking.

Distribution: Mexico to Colombia.

Vehilius scheria Plotz

Barro Colorado Island, C. Z., Jan. 5–6, 1929, 2 males, Feb. 15, 1928, 1 male.

These specimens seem to agree reasonably well with the Draudt figure and text, except the anal angle of the forewing is not "almost whitish"; it is much lighter than the rest of the wing with a small diffuse whitish spot. However, the immaculate, black upper surface of the wings; and beneath, the steely-blue costal and apical half of the primaries, and entire secondaries, except a streak through the abdominal fold, which is brown, with the small but distinct, white, discal and sub-apical spots of the primaries, and curved row of the secondaries, seem to identify fairly well the species; which probably does not belong in this genus.

Distribution: Described from Brazil; Panama; French Guiana.

Vehilius celeus Mabille

Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 22, 1928, 3 males, 1 female.

These specimens are identified by the form of the male genitalia as figured by Dr. Lindsey (3). The species is not mentioned in the *Biologia*, or by Draudt.

Distribution: Lindsey (3) records from Brazil; Panama; Dutch Guiana.

Megistias tripunctata Latreille

Barro Colorado Island, C. Z., Oct. 19, 1928, 2 females; Dec. 19, 1928, 1 male, Dec. 26, 1928, 1 male; Tapia Bridge, Panama, Oct. 15, 1928, 2 females.

In the *Biologia* the spelling is "*tripunctatus*" but the original is as above.

Distribution: Mexico to Brazil.

Megistias labdacus Godman

Barro Colorado Island, C. Z., Oct. 13–18, 1928, 3 males; Summit, C. Z., Oct. 17, 1928, 4 males, 3 females; Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 20, 1928, 1 female; Ft. Amador, C. Z., Oct. 23, 1928, 4 males, 1 female; Tapia Bridge, Panama, Oct. 15, 1928, 4 males, 1 female.

A small, inconspicuous, low-flying and very abundant species. It is spelled "labdaces" in the explanation of the *Biologia* plate. 101, but as above in the text.

Distribution: Mexico to Dutch Guiana; Trinidad.

Megistias edata Plotz

Pedro Miguel, C. Z., Oct. 20–22, 1928, 4 females; Summit, C. Z., Oct. 17, 1928, 1 female; Old Panama City, Panama, Oct. 16, 1928, 1 female.

This is *isus* Godman in the *Biologia*, which Godman sinks to *edata* Plotz in his notes on the Plotz species.

Distribution: Mexico to Guiana.

Megistias noctis Plotz

Barro Colorado Island, C. Z., Oct. 13–19, 1928, 4 males, 7 females, Jan. 10–21, 1929, 2 males; Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 20–22, 1928, 19 males, 5 females; Summit, C. Z., Oct. 17, 1928, 1 male; Tapia Bridge, Panama, Oct. 15, 1928, 1 female; Corozal, C. Z., Feb. 1, 1929, 1 male.

This species is recorded in the *Biologia* as *epiberus* Mabille, which Godman, in his notes on the Plotz species, sinks to the Plotz name, *corticea,* and further says that *noctis* Plotz and *lysias* Plotz are doubtless varieties of the same species. Although Plotz figured these three things in his unpublished drawings in the following order; *corticea* No. 591; lysias No. 623; noctis No. 1431, he actually published the description of *noctis* first, Stett. Ent. Zeit, vol. 44, no. 1–3, page 56, 1883; then *corticea* on the same page, and *lysias* in the same publication no. 4–6, page 200, therefor, *noctis* having been published first, has priority over the other two, and holds the name of the species. The name *corticea* was applied to individuals with a well defined fulvous band on the primaries, *noctis* to those where this band is greatly reduced or obsolescent, and *lysias* to an intermediate form, but the names *corticea* and *lysias* are hardly worth retaining as the species is exceedingly variable in both size and maculation, even when from the same locality, as noted in the *Biologia.*

Distribution: Mexico to Brazil; Trinidad.

Megistias tripunctus Herrich-Schaffer

Barro Colorado Island, C. Z., Jan. 21, 1929, 2 females; Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 20–22, 1928, 1 female; Summit, C. Z., Oct. 17, 1928, 4 females; Tapia Bridge, Panama, Oct. 15, 1928, 1 female; Old Panama City, Panama, Oct. 16, 1928, 1 female; Patilla Pt., C. Z., Jan. 15, 1929, 1 female.

This species is not recorded in the *Biologia* from the Central American region.

Distribution: Panama; Dutch Guiana; Cuba; Jamaica; Dr. Lindsey (3) records Peru and Brazil; Skinner and Williams, Florida.

Vorates decorus Herrich-Schaffer

Barro Colorado Island, C. Z., Dec. 23, 1928, 1 male; Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 20, 1928, 1 male.

Distribution: Mexico to Brazil; Trinidad (Kaye).

Padraona epictetus Fabricius

Barro Colorado Island, C. Z., Oct. 19, 1928, 1 male, Dec. 26–28, 1928, 2 males, Jan. 4, 1929, 1 male, Feb. 16, 1929, 1 male; Pedro Miguel, C. Z. (Chiva Chiva Trail), Oct. 22, 1928, 2 males; Corozal, C. Z., Jan. 19, 1929, 1 male.

Distribution: Mexico to Paraguay.

Zenis calvina form dissoluta Plotz

Barro Colorado Island, C. Z., Jan. 6, 1929, 1 male.

This specimen seems to agree reasonably well with the Draudt figure and also with a single specimen in the collection of the writer, from Bolivia, however, there does not seem to be the hair-pencil or fold in which it lies, under vein 2 of the primaries, which Godman states is one of the characteristics of the genus. The identification may not be correct.

Distribution: Draudt gives for *valvina:* Bahia; Para.

Cœliades fiscella Hewitson

Barro Colorado Island, C. Z., Jan. 12, 1929, 1 male.

Distribution: Nicaragua to Amazons.

Flaccilla subrufescens Schaus

Barro Colorado Island, C. Z., Feb. 14, 1929, 1 male, 1 female, Jan. 8, 1929, 1 female.

This species was originally described in the genus *Carystus* but is placed in the National Collection in *Flaccilla,* with which it more nearly coincides in the form of the stigma in the male.

Distribution: Costa Rica; Panama.

Godmania silius Latreille

Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20, 1928, 1 male; Tapia Bridge, Panama, Oct. 15, 1928, 1 female.

Recorded in the *Biologia* in the genus *Cymænes;* Skinner and Ramsden, Proc. Acad. of Nat. Sciences, Phila., lxxv, page 321, 1923, propose the genus *Godmania* to replace *Cymænes* auct.; as the type of *Cymænes* Scudder is *Cobalus tripunctus* Herrich-Schaffer.

Distribution: Mexico to Brazil.

Godmania lunata race **silene** Plotz

Barro Colorado Island, C. Z., Oct. 13, 1928, 1 male, Dec. 22, 1928, 1 female, Jan. 6, 1929, 1 female, Jan. 21, 1929, 1 male.

Recorded in the *Biologia* as *Cymænes berus* Mabille, but Godman states in his notes on the Plotz species that *lunata* Plotz and *silene* Plotz both equal *berus* Mabille, the Plotz names having priority. An examination of the genitalia of one of the male specimens shows that it agrees with the *Biologia* figure of that of *berus*. The male specimens have the fulvous areas of the wings more reduced than the figure of *berus*, and as Draudt places *silene* as a form of *lunata* with reduced maculation these specimens are referred to that form. Two females associated with the males agree with the characters pointed out by Godman to separate this sex of *lunata* from *silius* and *malitiosa* females.

Distribution: Recorded from Costa Rica; Panama; Colombia; Brazil.

Methionopsis ina Plotz

Barro Colorado Island, C. Z., Dec. 28, 1928, 1 female, Feb. 6, 1929, 1 male.

Recorded in the *Biologia* as *modestus* Godman, but Godman sinks *modestus* to *ina* Plotz, in his notes on the Plotz species.

Distribution: Mexico to Brazil; Trinidad.

Methionopsis typhon Godman

Barro Colorado Island, C. Z., Feb. 21, 1929, 1 male.

Distribution: Guatemala to Panama.

Eprius veleda Godman

Corozal, C. Z., Jan. 19, 1929, 1 male.

This genus was originally spelled "*Epeus*" but changed to *Eprius* in the Supplement.

Distribution: Mexico to Panama; Trinidad (Kaye).

Callimormus juventus Scudder

Corozal, C. Z., Jan. 22, 1929, 1 male.

Distribution: Mexico to Brazil.

Callimormus gracilis Felder

Barro Colorado Island, C. Z., Oct. 18–19, 1928, 3 males, Dec. 22–29, 1928, 3 males, 2 females, Jan. 10, 1929, 2 males.

A small, low-flying species.

Distribution: Mexico to Venezuela; Lindsey (3) adds Peru; Trinidad.

Callimormus corades Felder

Barro Colorado Island, C. Z., Oct. 14, 1928, 1 male; Pedro Miguel, C. Z., (Chiva Chiva Trail), Oct. 20, 1928, 2 males; Ft. Amador, C. Z., Oct. 23, 1928, 1 male; Summit, C. Z., Oct. 17, 1928, 2 males, 1 female; Tapia Bridge, Panama, Oct. 15, 1928, 1 male.

Distribution: Mexico to Brazil; Trinidad.

Mnestheus ludens Mabille

Barro Colorado Island, C. Z., Jan. 7, 1929, 1 male, Feb. 15, 1929, 1 male.

Distribution: Panama to Venezuela.

Mnestheus species?

Barro Colorado Island, C. Z., Dec. 23, 1928, 1 female.

The writer is unable to identify this specimen, and in the absence of a male the generic affinity is uncertain, it is tentatively placed in this genus on the general characteristics.

Orses seneca Latreille

Barro Colorado Island, C. Z., Dec. 26, 1928, 1 female; Corozal, C. Z., Jan. 21, 1929, 1 female.

These specimens closely agree with a specimen from Paraguay in the collection of the writer. Godman does not record the species from the Central American region but mentions it in a footnote, as *cotona* Hewitson. Draudt places *crotona* Hewitson in the genus *Perichares*, but Riley puts it in *Orses* as a synonym of *seneca*, and that course is followed here.

Distribution: Panama to Brazil.

Thracides luda Hewitson

Barro Colorado Island, C. Z., Oct. 18, 1928, 1 female, Jan. 6, 1929, 1 female.

Distribution: Honduras to Guiana.

Thracides aroma Hewitson

Corozal, C. Z., Jan. 19, 1929, 1 male.

Distribution: Costa Rica to Amazons.

Thracides salius Cramer

Barro Colorado Island, C. Z., Jan. 5, 1929, 1 female.

Distribution: Mexico to Argentine.

Thracides telegonus Hubner

Barro Colorado Island, C. Z., Oct. 19, 1928, 1 male.

Telegonus Hubner is sometimes placed as a synonym of *longirostris* Sepp, but Riley has pointed out certain differences.

Distribution: in writer's collection from Panama, French Guiana, Bolivia, Trinidad.

Thracides antoninus Latreille

Barro Colorado Island, C. Z., Jan. 8, 1929, 1 female.

The remarks under *telegonus* also apply to this species.

Distribution: in collection of the writer from French Guiana, Bolivia, Ecuador, Trinidad, Panama.

Perichares coridon Fabricius

Barro Colorado Island, C. Z., Oct. 18, 1928, 1 female, Dec. 25, 1928, 1 male.

Distribution: Mexico to Brazil; Antilles.

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RECORDS AND DESCRIPTIONS OF NEOTROPICAL CRANE-FLIES (TIPULIDÆ, DIPTERA), IX

BY CHARLES P. ALEXANDER

AMHERST, MASS.

The preceding part under this general title was published in 1930 (JOURNAL N. Y. ENTOMOLOGICAL SOCIETY, 38: 109–120). The crane-flies discussed at this time were collected in the Greater Antilles by Doctors J. G. Myers and P. D. Sanders; in Chile by Mr. D. S. Bullock; and in Santa Catharina, Brazil, by Mr. Friedrich Schade. I wish to express my deepest thanks to the above-mentioned entomologists for the privilege of retaining the types of the species here described.

Genus *Limonia* Meigen

Limonia (Dicranomyia) clavigera new species.

General coloration brownish gray; antennæ black throughout; wings grayish subhyaline, the oval stigma pale brown; *Sc* short, Sc_1 about one-half as long as *Rs*; cell *1st* M_2 closed; male hypopygium with the ventral dististyle fleshy, the outer apical region bearing a long tail-like fleshy extension that terminates in a blackened club.

MALE.—Length about 4.5 mm.; wing 5.3 mm.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval, clothed with a delicate white pubescence; verticils short and inconspicuous. Head brownish gray, clearer gray on the orbits.

Mesonotum brownish gray, the præscutum with three darker brown stripes; scutal lobes brown, the median region and posterior sclerites dark, heavily pruinose. Pleura pruinose. Halteres pale, the knobs blackened. Legs with the coxæ and trochanters yellowish; femora yellowish brown,

their bases brighter, the outer ends darkened; tibiæ and tarsi black. Wings grayish subhyaline, the oval stigma pale brown; veins black, those of the cord and outer end of cell *1st* M_2 stouter and semi-obliterated. Venation: Sc_1 ending opposite or just before the origin of *Rs*, Sc_2 some distance from its tip, Sc_1 alone about one-half *Rs*; cell *1st* M_2 closed, relatively small; second section of M_{1+2} only about two-fifths the distal section; *m–cu* before the fork of *M*.

Abdominal tergites black, the extreme caudal margins paler; sternites brown; hypopygium black, the ventral dististyle conspicuously pale. Male hypopygium with the tergite transverse, the median area of the caudal margin gently emarginate. Basistyle small, the ventromesal lobe large. Ventral dististyle large and fleshy, on the outer apical region bearing a long fleshy tail-like extension that is approximately as long as the remainder of the style, its apex dilated into a blackened club; rostral prolongation stout, blackened, with two approximated spines. Gonapophyses blackened, the mesal apical lobe gently curved.

Habitat.—Chile.

Holotype, ♂, Angol, Malleco, November 28, 1929 (D. S. Bullock).

Limonia (*Dicranomyia*) *clavigera* is highly isolated and peculiar in the tail-like extension of the ventral dististyle of the male hypopygium.

Limonia (Dicranomyia) trinitatis new species.

General coloration gray, the præscutum behind with four short blackish spots or shortened stripes; antennæ black throughout; wings whitish subhyaline, with a diffuse gray pattern that is somewhat reticulated; *Sc* short, Sc_1 longer than *Rs*; cell M_2 open by the atrophy of *m*.

FEMALE.—Length about 4 mm.; wing 4.6 mm.

Rostrum and palpi black. Antennæ black throughout; flagellar segments short-oval. Head gray; anterior vertex narrow.

Mesonotal præscutum brownish gray, near the suture with four short velvety-black spots or short stripes, most evident when viewed slightly from the front; median region of anterior part of præscutum less evidently infuscated; scutal lobes dark gray, darkened medially, the median region and disk of scutellum clearer gray; scutellum darkened behind; postnotal mediotergite grayish brown. Pleura gray, indistinctly lined with brown, the posterior dorso-pleural region more ochreous. Halteres pale. Legs with the coxæ infuscated basally, their apices paling to yellow; trochanters yellow; femora yellow, the tips passing into brown; tibiæ brownish yellow, the tips narrowly darkened; tarsi passing into brown. Wings whitish subhyaline, with a very diffuse gray pattern that is more or less reticulate, occurring as ill-delimited spots and clouds in all the cells, more darkened in the costal region; veins light brown. Venation: Sc_1 ending just before the

origin of *Rs*, Sc_2 some distance from its tip, Sc_1 alone exceeding *Rs*; *Rs* arcuated, about one-half longer than the even more strongly arcuated basal section of R_{4+5}; cell M_2 open by the atrophy of *m*; *m–cu* about one-third its length before the fork of *M*.

Abdomen dark brown, sparsely pruinose. Valves of ovipositor relatively short and stout.

Habitat.—Cuba.

Holotype, ♀, Buenos Aires, Trinidad Mts., forest capping limestone (diente perro) peak, altitude 2600 feet, September 15, 1929 (J. G. Myers); Coll. No. C 203.

Limonia (*Dicranomyia*) *trinitatis* is very distinct from *L.* (*D.*) *reticulata* (Alexander) in the ground-color of the body, the venation, and the diffuse gray pattern of the wing.

Genus *Polymera* Wiedemann

Polymera (Polymerodes) catharinæ new species.

Size small (wing, ♂, 3.5 mm.); antennæ black throughout; thoracic dorsum brownish black; pleura yellowish brown, with a broad black stripe; legs brownish black, the tarsi only slightly paler; wings narrow, tinged with blackish; cell M_1 lacking, cell M_3 short and sprawly; Sc_1 and *Rs* long; vein *2nd A* short; macrotrichia of veins short and relatively inconspicuous.

MALE.—Length about 3 mm.; wing 3.5 mm.; antenna about 5 mm.

Rostrum and palpi black. Antennæ (♂) elongate, black throughout; flagellar segments only weakly binodose, the basal node shorter than the apical. Head black.

Thoracic dorsum brownish black, the posterior sclerites a trifle paler. Pleura yellowish brown to dark brown, with a broad black stripe. Halteres dusky. Legs brownish black, the outer segments only a trifle paler. Wings with a strong blackish tinge; pale longitudinal streaks adjoining veins *M* and *1st A*; veins brownish black. Wings conspicuously narrower than in other species of the subgenus. Macrotrichia of veins short and relatively inconspicuous. Venation: Sc_1 ending beyond three-fourths the length of *Rs*, Sc_2 some distance from its tip, Sc_1 alone exceeding *m–cu*; *Rs* elongate, angulated at origin, nearly three times R_{2+3+4}; R_{1+2} longer than R_{2+3+4}; cell M_3 short and sprawly; cell *2nd A* short, vein *2nd A* ending opposite the origin of *Rs*; anterior arculus weakly preserved.

Abdomen black, the sternites more brownish black.

Habitat.—Brazil.

Holotype, ♂, Jaraguá, Santa Catharina, August 24, 1929 (F. Schade).

By means of my key to the species of the subgenus *Polymerodes* (Can. Ent., 52: 143; 1920), the present species runs to

couplet 2, disagreeing with the included species in the broad pleural stripe. The species is further characterized by the unusually narrow wings, with the macrotrichia of the veins short and inconspicuous.

Genus *Shannonomyia* Alexander

Shannonomyia myersiana new species.

General coloration of mesonotum reddish yellow; antennæ (♂) elongate, exceeding the body; pleura chiefly darkened; wings gray, the small stigma pale brown; macrotrichia in outer cells of wing; cell M_2 open by atrophy of *m*.

MALE.—Length about 5 mm.; wing 6.5 mm.; antenna about 6 mm.

FEMALE.—Length about 6 mm.; wing 5.5 mm.

Rostrum and palpi black. Antennæ (♂) elongate, exceeding the body in length; scapal segments blackish, the flagellum pale brown, the outer segments again more darkened; flagellar segments elongate-cylindrical, with conspicuous erect setæ that are much shorter than the segments; outer segments shorter, the setæ equal to or exceeding the segments. In the female, the flagellar segments are long-oval, gradually decreasing in size outwardly, the basal segment being nearly as long as the succeeding two taken together. Head dark gray, the anterior vertex more yellowish pollinose.

Mesonotal præscutum reddish yellow, more darkened medially; pseudosutural foveæ and tuberculate pits lacking; posterior sclerites of mesonotum more brownish yellow, especially the scutal lobes. Pleura chiefly dark brown, somewhat paler ventrally. Halteres relatively elongate, pale. Legs with the coxæ and trochanters pale; remainder of legs brownish yellow, the outer segments a little darkened. Wings broader in male than in female, grayish, the small stigma pale brown; veins pale brown. Abundant macrotrichia in the outer ends of cells beyond the cord, more extensive in male (cells R_2 to M_4, inclusive); in female more sparse, in cells R_3 to M_3, inclusive. Venation: Sc_1 ending opposite the fork of *Rs*, Sc_2 at its tip; R_2 at or close to fork of R_{3+4}; vein R_3 nearly straight, parallel to distal end of R_{1+2}; R_4 deflected strongly caudad on outer end; inner ends of cells R_4, R_5 and *1st* M_2 in transverse alignment; cell M_2 open by atrophy of *m*; *m-cu* more than one-half its length beyond the fork of *M*.

Abdominal tergites dark brown, the sternites paler. Male hypopygium with the outer dististyle blackened and bifid at tip. Ovipositor with elongate valves.

Habitat.—Jamaica.

Holotype, ♂, Blue Mts., altitude 6000 feet, January 30, 1930 (J. G. Myers); Coll. No. 982.

Allotopotype, ♀, altitude 5447 feet, January 29, 1930 (J. G. Myers); Coll. No. 975.

Shannonomyia myersiana is named in honor of the collector, Dr. John G. Myers, to whom I am greatly indebted for many Tipulidæ from all parts of the world. The reference of the species to this genus seems correct, despite the elongate antennæ of the male and the macrotrichia of the outer cells of the wing. The aberrant crane-fly described by the present writer from Panama as *Gnophomyia olssoni* (JOURN. N. Y. ENT. SOC., 27: 144; 1919) seems unquestionably to be allied to *myersiana* and the two forms may best be considered as representing a highly specialized offshoot of *Shannonomyia*.

Shannonomyia brevicula new species.

General coloration reddish brown; antennæ short; head silvery gray; pronotum and lateral pretergites silvery gray; wings tinged with yellow, with a sparse brown pattern, including small spots along cord, outer end of cell *1st* M_2 and as marginal seams; *Rs* relatively short, arcuated at origin; cell R_3 unusually small, vein R_3 being shorter than R_{3+4}; cell *1st* M_2 closed, elongate, shorter than vein M_{1+2} beyond it.

MALE.—Length about 4 mm.; wing 4.3 mm.

Rostrum and palpi brownish black. Antennæ short, the basal segments pale yellow, the outer segments brown. Head silvery gray, the genæ a little darker.

Pronotum above and lateral pretergites likewise light whitish or silvery gray. Mesonotum opaque reddish brown, the præscutum very narrowly and indistinctly darkened medially; scutal lobes more darkened; scutellum and postnotal mediotergite dusky, weakly pruinose. Pleura yellowish brown, clearer yellow ventrally. Halteres pale yellow. Legs with the coxæ and trochanters yellow; remainder of legs long and slender, yellow, the tips of the tibiæ weakly darkened; terminal tarsal segments slightly infuscated. Wings with a yellowish tinge, sparsely patterned with brown, including small spots at arculus, origin of *Rs*, fork of *Sc*, R_2, along cord and outer end of cell *1st* M_2; marginal spots on R_3, R_4, M_{1+2}, M_3, M_4, Cu_1 and the anal veins; veins pale, darker in the infuscated areas. Venation: *Sc* short, Sc_1 ending about opposite three-fourths the length of the relatively short *Rs*, Sc_2 close to its tip; cell R_3 very short, vein R_3 being shorter than R_{3+4}; vein R_4 deflected strongly cephalad at outer end; cell *1st* M_2 elongate but shorter than vein M_{1+2} beyond it; *m–cu* more than one-half its length beyond the fork of *M*.

Abdominal tergites dark brown, the sternites paler; hypopygium obscure yellow.

Habitat.—Cuba.

Holotype, ♂, Buenos Aires, Trinidad Mts., in tree-fern ărroyo, altitude 2300 feet, September 16, 1929 (J. G. Myers); Coll. No. C 205.

Shannonomyia brevicula is very distinct from the other Antillean species of the genus. The shape of cell R_3 is much as in *S. triangularis* (Alexander) of Porto Rico but the medial field of wing is entirely different.

Genus *Atarba* Osten Sacken

Atarba (Atarba) bifurcula new species.

General coloration yellow, each scutal lobe with two black areas; antennal flagellum weakly bicolorous; femora yellow, with a narrow brown subterminal ring; wings yellow, with a heavy brown pattern, including a dark brown stigmal spot; male hypopygium with the ædeagus shaped like a tuning-fork, the arms being approximately twice the length of the stem.

MALE.—Length about 6 mm.; wing 6.3 mm.

FEMALE.—Length 6.5 mm.; wing 6–6.5 mm.

Rostrum yellow; basal segment of palpus yellow, the remaining segments brownish black. Antennæ with the scapal segments yellow, the basal flagellar segments bicolorous, on the first segment the basal half yellow, the remainder dark brown; on the succeeding segments with less than the basal fourth of the segment yellow, the amount of this color decreasing outwardly, flagellar segment seven being uniformly darkened; flagellar segments (♂) more elongate than in *punctiscuta*. Head polished yellow, more or less obscured, in the allotype blackened.

Mesonotal præscutum shiny yellow to chestnut yellow, in the female with a capillary darker median vitta; scutum yellow, each lobe with two polished black areas, the lateral one larger; scutellum and postnotal mediotergite more or less blackened. Pleura yellow to chestnut-yellow, highly polished. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters yellow; femora yellow, before tips with a narrow dark brown annulus, the extreme apex brownish yellow; tibiæ and tarsi yellow, the three terminal segments of the latter blackened. Wings with a strong yellow suffusion, conspicuously patterned with dark brown, including the stigma and narrow seams at arculus, origin of *Rs*, along cord and outer end of cell *1st* M_2; in the female, the pattern is even heavier, the seams being broader and with the basal halves of cells *M* and *Cu* conspicuously washed with brown. Venation: *Sc* relatively short, Sc_1 ending about opposite one-fourth to two-fifths the length of *Rs*; branches of *Rs* diverging very gradually; cell *1st* M_2 short-rectangular; *m–cu* close to fork of *M*.

Abdomen yellow, in male with a subterminal dark brown ring. In female, the tergites more uniformly brownish black, the sternites yellow. Male hypopygium with the outer dististyle toothed only on distal fourth. Inner dististyle longer, the outer half curved. Aedeagus profoundly bifid, the long arms approximately twice the stem.

Habitat.—Brazil.

Holotype, ♂, Jaraguá, Santa Catharina, September 21, 1929 (F. Schade).

Allotopotype, ♀.

Paratopotype, ♀, October 2, 1929 (F. Schade).

Atarba bifurcula is allied to *A. punctiscuta* Alexander (Paraguay) in the coloration of the body and legs. The wing-pattern is much heavier, especially the conspicuous stigma, and the details of venation are distinct. The peculiar structure of the ædeagus will probably be found to occur also in *punctiscuta*. The wing-pattern of the present species is more conspicuous than in any other known species of *Atarba*.

Genus *Aphrophila* Edwards

Aphrophila carbonaria new species.

General coloration intense black, sparsely pruinose; antennæ entirely black; knobs of halteres darkened; male hypopygium with the region of the tergite extended caudad into a single point.

MALE.—Length about 5 mm.; wing 6 mm.

Rostrum, palpi and antennæ black. Head black, sparsely pruinose.

Thorax black, sparsely pruinose, the præscutum with a slightly elevated more intensely blackened line; dorso-pleural region paler. Halteres pale, the knobs brown. Legs with the coxæ dark brown; trochanters brownish yellow; femora black, the bases yellow, very narrow on the fore legs, broader on the posterior legs, where about the basal half is included; tibiæ and tarsi black. Wings with a slight brownish tinge; stigma oval, pale brown; a dusky axillary wash; a vague darkening along vein *Cu*; veins dark brown, the cord, outer end of cell *1st* M_2 and anterior branches of *Rs* paler. Venation: *Rs* relatively long, exceeding R_{2+3+4}; *m-cu* close to fork of *M*.

Abdomen black, the male hypopygium a little paler. Hypopygium with the dististyle quite as in *chilena*. Region of tergite extended into a single median point between the basistyles, in *chilena* this area being broader and conspicuously bidentate.

Habitat.—Chile.

Holotype, ♂, Angol, Malleco, November 25, 1929 (D. S. Bullock).

Associated in collections with *Aphrophila chilena* Alexander. *A. carbonaria*, and the species next described as *A. multidentata*, are allied to *A. chilena* but evidently distinct.

Aphrophila multidentata new species.

General coloration brownish gray, the præscutum with three dark brown stripes; antennæ black throughout; caudal half of postnotal mediotergite blackened; halteres pale; axillary region of wing not darkened; ovipositor with dorsal margin of each tergal valve with from 12 to 14 small teeth.

FEMALE.—Length about 5.3 mm.; wing 6.2–6.3 mm.

Rostrum and palpi dark brown. Antennæ black throughout. Head dark brown, the anterior vertex light silvery gray.

Mesonotal præscutum brownish gray, with three dark brown stripes, the broad median stripe further divided by a capillary elevated line; centers of scutal lobes darkened; median region of scutum, and the scutellum testaceous yellow; postnotal mediotergite bicolorous, the cephalic half yellowish testaceous, the posterior half blackened. Pleura plumbeous. Halteres obscure yellow. Legs with the coxæ brownish yellow; trochanters yellow; femora brownish yellow; tibiæ and tarsi brown. Wings tinged with grayish yellow, the small stigma brown; axillary region not darkened; veins brown, *Sc* and the prearcular veins more yellowish.

Abdomen dark brown, the pleural membrane yellow; genital segment brownish yellow, the tergal valves of ovipositor chestnut brown. Tergal valves of ovipositor with a series of from 12 to 14 small teeth, the more basal ones not conspicuously larger. In *chilena*, these valves have a series of about 7 teeth, the basal ones being larger and more conspicuous.

Habitat.—Chile.

Holotype, ♀, Angol, Malleco, February 1, 1930 (D. S. Bullock).

Paratopotype, ♀.

Genus *Trentepohlia* Bigot

Trentepohlia (Paramongoma) cubitalis new species.

General coloration pale yellow; wings yellow, stigma lacking; a conspicuous brown seam on distal half of vein Cu_1.

FEMALE.—Length about 6 mm.; wing 5.5 mm.

Rostrum and palpi yellow. Antennæ brown throughout. Head dull ochreous yellow.

Mesonotum light yellow, the præscutal bristles black, small but conspicuous. Pleura light yellow. Halteres yellow. Legs yellow, the terminal tarsal segments scarcely darker. Wings pale yellow, without stigma; a conspicuous brown seam on distal half of Cu_1; veins pale yellow, darker in the clouded area. Venation: R_2 about one-half longer than R_{3+4}; R_5 diverging strongly from R_4; *m–cu* shortly before fork of *M*.

Abdominal tergites yellow, the bases of the segments weakly infuscated to produce a slight bicolorous appearance; sternites and genital segment pale yellow. Ovipositor with elongate tergal valves.

Habitat.—Brazil.

Holotype, ♀, Jaraguá, Santa Catharina, September 29, 1929 (F. Schade).

Trentepohia cubitalis is very different from the other described species of *Paramongoma*. The venation is of the general type of *T.* (*P.*) *longifusa* (Alexander), differing in the details of length and course of veins.

Genus *Teucholabis* Osten Sacken

Teucholabis (Teucholabis) catharinensis new species.

Size large (length over 10 mm.); general coloration reddish, the præscutum with three darker stripes; head black; femora yellow, the tips narrowly black; wings yellow with three pale brown crossbands; male hypopygium with the spine of the basistyle long, the apical flanges not serrate, merely setiferous.

MALE.—Length about 11 mm.; wing 9.5 mm.

FEMALE.—Length about 14 mm.; wing 8.5 mm.

Rostrum only a little shorter than the remainder of the head, dark reddish, the tip more blackened; palpi black. Antennæ with the basal segment reddish brown, the remainder black; flagellar segments black, long-oval, becoming more attenuate outwardly. Head black, with more or less distinct violaceous reflexions, paling to reddish behind.

Pronotum obscure yellow. Mesonotal præscutum yellow, highly polished, with three darker stripes, the lateral stripes more blackish than the reddish brown median area; posterior sclerites of mesonotum yellow, the scutal lobes extensively dark brown, the scutellum more or less darkened at base. Pleura pale, extensively variegated with black, including a dorsal area involving the propleura and anepisternum, the ventral sternopleurite and an area on the pleurotergite; entire pleura with a dense appressed silvery pubescence to produce a pruinose appearance. Halteres yellow, the knobs blackened, their extreme tips again pale. Legs with the coxæ yellow, the outer face weakly darkened; trochanters yellow; femora yellow, the tips narrowly blackened, the amount subequal on all legs; tibiæ and tarsi yellow, the tips of the latter black. Wings yellow, with three conspicuous pale brown crossbands, the second at the cord, the last narrowest, including the wing-apex; stigmal area subtriangular, darker than the crossbands; veins yellow, darker in the infuscated areas, especially along the cord and outer end of cell *1st* M_2. Venation: Sc_1 ending opposite or beyond mid-length of Rs, Sc_2 some distance from its tip; R_2 oblique in position, considerably longer than the arcuated R_{1+2}; cell *1st* M_2 closed.

Abdomen (♂) reddish, the sternites narrowly darkened sublaterally. In female, the abdomen more blackened, the caudal margins of the segments paler; genitalia of both sexes reddish. Male hypopygium with the spine

of basistyle long and acute, the mesal face before apex with appressed setulæ; marginal flange at apex of basistyle smooth, conspicuously setiferous, not serrated as in *melanocephala*. Outer dististyle a simple yellow rod that narrows to a small blackened spine, the outer surface with coarse setæ. Inner dististyle bifid.

Habitat.—Brazil.

Holotype, ♂, Jaraguá, Santa Catharina, December 24, 1929 (F. Schade).

Allotopotype, ♀, November 17, 1929 (F. Schade).

Teucholabis catharinensis runs to *T. melanocephala* (Fabricius), from which it differs especially in the large size, wing- and leg-pattern and structure of the male hypopygium.

Teucholabis (Teucholabis) nigrosignata new species.

General coloration reddish yellow; head yellow; mesonotal præscutum with three incomplete black stripes, the outer ones occupying the lateral margins of the sclerite; femora yellow, the tips broadly and equally blackened; wings whitish subhyaline, with the stigma and narrow seams on cord and outer end of cell *1st* M_2 darkened; *Sc* short, Sc_2 before origin of the arcuated *Rs*; branches of *Rs* divergent, cell R_2 at margin conspicuously narrower than cell R_4.

MALE.—Length about 4.5 mm.; wing 4.5 mm.

FEMALE.—Length about 4.5 mm.; wing 4.2 mm.

Rostrum obscure yellow; palpi brown. Antennæ with the first scapal segment obscure yellow; second segment yellowish brown; flagellum black; basal flagellar segments subglobular to very short-cylindrical, the outer segments more slender, passing into oval. Head yellow, more infuscated behind and on the genæ.

Pronotum yellow. Mesonotal præscutum reddish yellow, with three incomplete black stripes, the median stripe becoming obsolete at about midlength, the outer stripes occupying the lateral margins of the sclerite, in some cases obsolete behind, in others extended across the suture onto the cephalic-lateral portions of the scutal lobes; median region of scutum and the scutellum light yellow; postnotal mediotergite dark with the base yellow or with a median yellow triangle, the point directed backward. Pleura reddish, with a ventral longitudinal whitish stripe that occupies the dorsal sternopleurite, the meral region, and sends a spur dorsad onto the pteropleurite; pleurotergite black. Halteres dusky, the knobs yellow. Legs with the coxæ and trochanters reddish yellow; femora yellow, the tips broadly and conspicuously blackened, the amount subequal on all legs; tibiæ obscure yellow at base, soon passing into black; tarsi black. Wings whitish subhyaline, with a restricted dark pattern; stigma subcircular, brownish black; narrow dark seams along cord and outer end of cell *1st* M_2; veins

dark brown, the costal region at near midlength paling to yellow. Venation: *Sc* short, Sc_1 ending about opposite one-fourth the length of the strongly arcuated *Rs*, Sc_2 some distance from its tip and before the origin of *Rs*; R_2 at fork of *Rs*; anterior branch of *Rs* gently sinuous to nearly straight, at outer end deflected slightly cephalad so cell R_2 is conspicuously narrower than cell R_4; cell *1st* M_2 widened outwardly, the lower face longer than vein M_4 beyond it; *m–cu* at or shortly before fork of *M*.

Abdominal segments black, ringed caudally with reddish yellow, the amount of the latter increasing outwardly, the subterminal segments more uniformly pale; hypopygium black. Sternal pocket (♂) broadly U-shaped. Male hypopygium with the spine of the basistyle nearly as long as the outer dististyle. Outer dististyle simple, the apex glabrous, the margin at near midlength with a series of from 6 to 8 acute serrations. Inner dististyle with the blade-like apical portion expanded, terminating in a bidentate beak.

Habitat.—Cuba.

Holotype, ♂, Trinidad Mts., in cafetāl, altitude 2000 feet, September 14, 1929 (J. G. Myers); Coll. No. C 189.

Allotopotype, ♀.

Paratopotypes, 2 ♂♀.

Teucholabis nigrosignata is distinct from all of the now numerous Neotropical species of the genus. The venation is most nearly approached by species such as *T. bruneri* Alexander and *T. submolesta* Alexander, but the species is very distinct.

Genus *Gonomyia* Meigen

Gonomyia (Progonomyia) quinqueplagiata new species.

General coloration yellow; thoracic dorsum with five polished black areas, three being on the præscutum and representing the anterior ends of the præscutal stripes; wings yellow, the small stigma pale brown; R_2 less than its own length beyond the fork of *Rs*; male hypopygium with the outer dististyle a flattened, pale, parallel-sided blade; inner dististyle flattened, pale, the outer angle produced into a spine.

MALE.—Length about 4 mm.; wing 5.2 mm.

Rostrum obscure yellow; palpi brownish black. Antennæ with the scapal segments bright yellow; flagellum black, the base of the first segment paler; flagellar segments oval, becoming smaller outwardly. Head yellow.

Pronotum yellow, darkened laterally. Mesonotal præscutum reddish yellow, clearer yellow laterally, with three circular to oval polished black areas that represent the cephalic ends of the præscutal stripes; scutal lobes chiefly covered by extensive black areas; scutellum brownish yellow, the caudal margin clearer yellow; postnotal mediotergite yellow, the lateral margins

of the sclerite conspicuously darkened. Pleura yellow, with two longitudinal areas of blue pruinosity, appearing as more or less distinct longitudinal stripes. Halteres relatively elongate, dusky, the bases of the knobs darkened, the apices brightening to yellow. Legs with the coxæ and trochanters yellow; femora and tibiæ brownish yellow, the tips of the latter narrowly darkened; tarsi passing into black. Wings relatively long and narrow, yellow, the small stigma pale brown; veins brown, those in the basal and costal regions more yellow. Venation: *Sc* long, Sc_1 ending at near two-thirds the length of the long *Rs*; R_2 less than its length beyond fork of *Rs*, R_{3+4} considerably longer than R_2; R_4 long and gently sinuous, nearly four times R_2; *m–cu* at fork of *M*.

Abdomen yellowish brown, the hypopygium yellow. Male hypopygium with the outer dististyle a pale flattened blade that is nearly parallel-sided, or gently expanded outwardly, the tip more truncate. Inner dististyle a flattened pale blade, the outer angle produced into a spine. Aedeagus broad-based, the apical half narrowed, the apex simple.

Habitat.—Brazil.

Holotype, ♂, Jaraguá, Santa Catharina, November 8, 1929 (F. Schade).

Gonomyia (Progonomyia) quinqueplagiata is very different from other described species of the subgenus, being most nearly allied to species such as *thiosema* Alexander.

Gonomyia (Lipophleps) cubana new species.

Belongs to the *manca* group; thoracic pleura brownish gray, striped longitudinally with white; knobs of halteres yellow; wings with a strong brown suffusion; male hypopygium with the dististyle simple, entirely fleshy; phallosome consisting of four chitinized structures, the two larger more heavily chitinized.

MALE.—Length about 3 mm.; wing 3 mm.

Rostrum orange-yellow; palpi brownish black. Antennæ black throughout. Head yellow, the center of the vertex darkened.

Anterior lateral pretergites pale yellow. Mesonotum grayish brown; scutellum yellow, the central portion at base brownish gray; postnotum gray. Pleura brownish gray, with a broad white longitudinal stripe extending from behind the fore coxæ to the abdomen; dorsopleural region pale yellow; a yellowish area beneath the wing-root. Halteres pale yellow, the outer portion of stem dusky. Legs with the coxæ and trochanters yellow; remainder of legs broken. Wings with a strong brown suffusion, the stigmal region a little darker; veins pale brown. Venation: Sc_1 ending a distance before the origin of *Rs* that is nearly the length of the latter; cell *1st* M_2 closed; *m–cu* a short distance before the fork of *M*.

Abdominal tergites dark brown, the lateral margins obscure yellow; hypopygium and sternites more uniformly pale. Male hypopygium with the

basistyle elongate; dististyle single, very pale throughout, scarcely differentiated from the apex of basistyle, terminating in two fasciculate setæ. Phallosome consisting of four chitinized structures, the longest straight on basal half, the outer half curved, narrowed to an acute point; a second heavily chitinized structure is broadly expanded at base, thence narrowed to a blunt blackened point, the surface before apex with scattered setulæ. Besides the above pair of structures, there are two slender paler rods, unequal in length, one presumably being the aedeagus.

Habitat.—Cuba.

Holotype, ♂, Trinidad Mts., in cafetāl, altitude 2000 feet, September 14, 1929 (J. G. Myers); Coll. No. C 189.

Gonomyia (*Lipophleps*) *cubana* is distinguished from the other described species of the *manca* group that have a simple entirely fleshy dististyle (*duurvoorti* Alexander, *haploa* Alexander, *inermis* Alexander, *manca* Osten Sacken, *maya* Alexander, *phoroctenia* Alexander and *tergofimbriata* Alexander) by the structure of the phallosome.

Gonomyia (Lipophleps) sandersi new species.

Belongs to the *manca* group; thoracic pleura striped; wings grayish, the costal region a trifle more whitish; male hypopygium with the basistyle produced beyond the point of insertion of the dististyle into a stout fleshy lobe; outer dististyle a curved chitinized hook; phallosome without paired blackened apophyses.

MALE.—Length about 3–4 mm.; wing 2.9–3.5 mm.

Rostrum brownish black; palpi black. Antennæ with the scapal segments orange, the flagellum brownish black. Head yellow, the center of the vertex darkened.

Anterior lateral pretergites sulphur yellow. Mesonotal præscutum grayish brown, the interspaces slightly more reddish brown, the lateral margins paling to yellow; scutum yellow, the centers of the lobes chiefly blackened; scutellum black, the margin broadly yellow; postnotal mediotergite yellow with a blackish lunate area on cephalic margin, the posterior margin more reddish brown. Pleura purplish, enclosing a conspicuous white longitudinal stripe, the ventral sternopleurite and meron more yellowish; dorsopleural region broadly brownish yellow. Halteres dusky, the knobs light yellow. Legs with the coxæ and trochanters yellow; femora brownish yellow, the tips darker; tibiæ and tarsi brownish black. Wings grayish, the stigmal region a trifle darker; costal and basal regions more whitish; veins light brown, somewhat paler in the costal region. Venation: Sc_1 ending a short distance before the origin of *Rs*, the latter weakly angulated to short-spurred at origin; cell *1st* M_2 closed; *m–cu* at or before the fork of *M*.

Abdominal tergites chiefly yellow, the median and caudal portions of the segments more infuscated; sternites and hypopygium yellow. Male hypopygium with the outer angle of basistyle produced caudad beyond the point of insertion of the dististyles into a short blunt lobe that is longer and stouter than the fleshy dististyle. Outer dististyle a curved chitinized hook that is almost as in *scimitar* and *puer*. Phallosome entirely pale, without paired blackened apophyses as in *scimitar;* a setiferous structure on either side that terminates in two small finger-like fleshy lobes; longest arm of phallosome a compressed blade, the apex obtusely rounded.

Habitat.—Cuba.

Holotype, ♂, Soledad, November 1, 1929 (P. D. Sanders).

Paratopotype, ♂; paratype, ♂, rocky creek in Seboruco forest, Soledad, October 11, 1929 (J. G. Myers); Coll. No. C 260.

Gonomyia (*Lipophleps*) *sandersi* is named in honor of the collector of the type, Dr. P. D. Sanders, student of the Psychodidæ. The species is related to *G.* (*L.*) *puer* Alexander, differing in the subapical insertion of the dististyles. In the latter respect, and in the structure of the dististyles, it agrees even more closely with *G.* (*L.*) *scimitar* Alexander, which, however, differs conspicuously in having paired blackened apophyses.

HORNET HABITS

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An element of danger always adds zest to the chase, whether it be hunting lions or collecting wasps. There is a lure to that about which lurks a touch of peril, and there is no branch of insect collecting where this is realized to the extent found in the study of wasps. Active, irritable and venomous, they form an item of interest to the investigator who does not prefer to come off unscathed.

My earliest interest in entomological matters was stimulated by a wasp sting. When I was at the age of about three or four years, these insects first forced themselves painfully upon my notice while I was walking close to a stone wall. After the effects had worn away somewhat, I was impelled by a desire to further investigate these "hot-footed" little beasts as well as by a temporary desire to exterminate them. This latter, in the case of several nests, I was able to do with the help of my grandfather and the hired man. These nests I kept as trophies of the chase, stored away in a large pasteboard box, the forerunner of an insect collection.

But despite the inconveniences experienced in their study, wasps and hornets are very interesting and all too little general knowledge is in print concerning them. As a matter of fact, it has been only during the past few years that the differentiation of our commonest forms has been accurately made and even the New York State list fails to record one of our most abundant species.*

Wasps and hornets, in the strictest sense of the term, belong to the Hymenopterous family Vespidæ and generically to *Vespa*, the Latin word for wasp. The term "hornet" was used for

* This species has recently been identified by comparison with specimens in the American Museum of Natural History, determined by Dr. J. Bequaert, as *Vespa vulgaris* L., the common wasp of Europe.

many years to designate one species—*Vespa crabro* Linnaeus, the English or Giant European hornet, as it is called in this country. This true hornet is the largest species of the genus occurring in the United States, and it is not a native species. It is presumed to have been accidentally introduced into the New York region many years ago—even before the advent of the English sparrow into this country—but it has spread very slowly. It now occurs in New Jersey, on Long Island, in the New York City region, up the Hudson nearly to Albany and in southern Connecticut, up the Connecticut River to Hartford. It might be interesting to state that Dr. E. P. Felt sometime ago showed me a sample of a lilac branch from the Chicago region which had been gnawed evidently by this insect, for this wasp or hornet is our only species of *Vespa* which is of economic importance as a destructive agent to vegetation. It has long been branded as a pest, due to its habit in obtaining material for its nest, of chewing around the twigs and branches of various living trees and shrubs, girdling them and thus producing their death. The list of trees thus attacked include lilac, birch, rhododendron, ash and probably others. Around New Haven, it is recorded by Britton[1] as causing damage to dahlias, gnawing the stalks.

Vespa crabro, in this country at least, is fond of the exuding sap of trees and the best way to collect them, aside from finding the nest, is to watch for them late in the summer around such trees as elms, maples or birches, where the bark has been bruised or otherwise injured and from which there is a flow of sap.

The European hornet is also predaceous and an interesting incident is recorded in J. G. Woods' "Insects at Home," of an individual of this species capturing the red atlanta butterfly. The scene is depicted in color in the frontispiece of the book.

In this country, they have been seen to kill and dismember cicadas, and Dr. Britton[2] states that Vanderwerken, a bee expert of Stamford, has reported that they frequently kill honey bees.

From my observations, I would say, however, that *Vespa crabro* is not nearly as active a predator as our own native

[1] Connecticut Agricultural Experiment Station Bulletin 226, p. 214, 1921.

[2] Connecticut Agricultural Experiment Station Bulletin 226, p. 214, 1921.

hornet, the so-called white-faced hornet, *Vespa maculata* L., which I shall discuss in more detail later. Its movements are slower, its sight is even poorer and all in all it is a much less aggressive creature in spite of its greater fame.

History is replete with mention of the hornet. It is referred to in the Bible, but whether or not the reference is actually to *Vespa crabro* is, of course, uncertain.

Nevertheless, it is stated in Deuteronomy, VII, 20 that in delivering the Hittites and Canaanites into the hands of the followers of Moses, "God will send the hornet among them, until they that are left and hide themselves from thee, be destroyed" and that this was actually done was affirmed in Joshua XXIV. 12 when that General in quoting Jehovah's words to the tribes of Israel said, "I sent the hornet before you which drove them out from before you, even the two kings of the Amonites; but not with the sword, nor with thy bow." A case, evidently, of where the sting—if you will pardon the paraphrase—was mightier than the sword!

The name hornet is evidently derived from the vicious buzz of the insect, just as the Latin word *Vespa* was derived from an attempt to simulate the sound.

Vespa crabro generally nests in hollow trees or in unused portions of buildings and makes a very large paper nest, which, however, as a rule is enclosed and not as conspicuous, therefore, as the great gray-white paper nest of our white-faced hornet.

Wasps and hornets furnish an excellent example of Alfred Russell Wallace's principle of warning coloration. These insects with their formidable stings are apt to be let severely alone by vertebrate predators and it is no doubt due to this fact that they owe their dominance in the insect world today. With the exception of butterflies and grasshoppers, bees and wasps are probably our most abundant and conspicuous large diurnal flying insects. They are certainly conspicuous; their contrasting black and white or black and yellow colors fairly cry out their identity. In fact, their coloration is so apparently a protection and warning that it is assumed by many unprotected insects, particularly in the Diptera. All through the Diptera, we find flies aping the color pattern of the outstanding vespids

of their region. In Europe there are at least two asilids—*Asilus crabroniformis* and *Laphria aurea*—patterned after *Vespa crabro*, the latter, by the way, being the more accurate mimic in spite of the name given to the first, while in this country the syrphid *Spilomyia fusca* is a "ringer" for our native white-faced hornet. These instances can be multiplied all over the globe.

Coming to our native white-faced hornet we find an insect which needs no introduction. It has probably introduced itself to many of you in the course of your collecting. Its large paper nest, before mentioned, is familiar to all, the tempting target of boyhood stone-throwing days.

The white-faced hornet, intent on hunting flies around barns, farm houses or other buildings or locations where *Musca domestica* may congregate, is a common sight in the rural districts of the Eastern States. In fact, one cannot help admiring the persistency of this insect in hunting down, in spite of its handicaps, this pest. In spite of repeated failure, the hornet keeps doggedly at it until he gets the fly. The active flies scatter at his or rather her approach and in open flight, the heavy bodied hornet is left far behind. But here is a fly which is lazily contemplating the world in its warm cozy place in the sun, or is sipping some choice viand in the form of some organic refuse clinging to the wood and before it perceives its danger, is pounced upon by the persevering hornet, which was evidently searching for just such a sluggard. Unfortunately, the hornet is further handicapped by poor vision, and it is a common sight to see a hornet butt headlong into a nailhead which it had evidently mistaken for its resting booty. The fact that it is no easy matter for the hornet to secure its prey may influence it to frequent places where flies are in great abundance so that even if several attacks may prove fruitless, there is still plenty of material from which to choose.

As soon as the victim is seized, the hornet follows a regular procedure. It immediately seeks a resting place where it assumes the following grotesque attitude. It suspends itself by one of the posterior legs, head downward and vigorously chews up its prey after clipping off the wings and legs.

The house fly (*Musca domestica*) is probably the most common prey, but the stable fly (*Stomoxys calcitrans*) is also frequently taken.

On August 25, 1916, at Southbridge, Mass., I observed hornets capturing the large carrion fly or "black blow fly" (*Phormia regina*) which swarmed in countless numbers around a small rendering plant.

On August 17, 1917, at Holland, Massachusetts, while walking along a cart road through some brushy woods, I was attracted by a dull, rattling buzz emanating from the dead leaves at my feet. There was a hornet in the act of dismembering a horse fly (*Tabanus orion* O. S.) actually much larger than itself. The fly was still alive and could vibrate its wings, which caused the noise against the dry leaves which first attracted my attention. The hornet lost no time in clipping off the head, wings, legs and abdomen of its prey. After consuming part of the latter, it flew off with the thorax.

On August 25, 1917, at Sturbridge, Mass., I saw a hornet capture a specimen of the gray drone fly (*Eristalis saxorum* Wied.) on a wild carrot blossom.

In August, 1912, I saw one seize a sarcophagid on a pile of lumber at Southbridge, Mass.

The white-faced hornet will kill large asilids, although at least four of our strongest species of the latter have been taken with *Vespa maculata* as prey. They are:

Proctacanthus philadelphicus Macquart
Proctacanthus nigriventris Macquart
Proctacanthus rufus Williston
Mallophora orcina Wiedeman.

In August, 1911, at Southbridge, Mass., I saw a hornet attack a large male *Deromyia umbrina*, while the latter was feeding on another insect. Both dropped to the ground among the grass roots and weed stalks, where in my eagerness to see what was going on, I frightened the hornet away before it had finished the job. The robber fly was still alive, but one wing had been bitten off and the abdomen was nearly severed.

In another case, the asilid was the aggressor. On July 23, 1912, I was watching a hornet at its hunting when a small asilid

(it turned out to be *Asilus erythrocnemius* Hine) flew recklessly at it. The hornet saw it coming and, turning in mid-air, met it with open jaws. It immediately began the chewing up operation, which I terminated in order to get the identification of the asilid.

On August 13, 1922, at Wallingford, Conn., I took a hornet in the net which had just captured the robber fly—*Leptogaster flavipes* Loew.

The encounter between a hornet and a large female *Deromyia umbrina* I have already recounted at a former meeting. In this case, a prolonged struggle ensued, in which the hornet finally freed itself from the grip of the fly and flew away.

So much for robber flies. I took on one occasion a hornet with a tachinid fly, too badly chewed for identification. This specimen was netted with its prey just as it was entering the nest.

Hornets frequently capture the small dragon or damsel flies. Species of the genera *Enallagma* and *Lestes* are often taken. One such instance I have noted as of September 1, 1916, was at the edge of a small pond in Southbridge, Mass., the grassy borders of which with their myriads of *Lestes forcipatus* served as a happy hunting ground for the hornets from a nest in a tree about a hundred yards away. In many cases the *Lestes* in coitu were seized.

On August 27, 1917, at Union, Conn., I saw a hornet carrying a yellow-jacket worker (*Vespa maculifrons*) which it dismembered in the same manner as other prey, except that it seemed to have a more difficult time in so doing.

All the foregoing refer to worker hornets, but I have seen the queens capture prey in the same manner as well. Two such instances are recorded here:

1. Large crane fly—Amherst, Mass., June 10, 1920.
2. Large crane fly—Sunderland, Mass., June 6, 1921.

In neither case was the fly obtained for specific identification, but both were large species of the genus *Tipula*, with the wings marked with black.

Of the smaller hornets, the two common wasps of Europe, *Vespa vulgaris* and *V. gemanica,* do not appear to occur in this country as for a long time recorded. At least the latter does

not. Our most abundant species is probably *Vespa maculifrons* = *V. communis*. This species nests in the ground and is one of the common, so-called "yellow-jackets." It is nearly omnivorous, feeding upon all sorts of organic matter. Honeydew, ripe fruit, cider, blood, garbage, honey, etc., are very attractive to it. They swarm over dead fish or meat. Occasionally they capture other insects. The following I have recorded as captured by worker *V. maculifrons*.

House fly—seen captured—Aug. 12, 1917. Southbridge, Mass. (at rendering plant).

House fly—seen captured—Sept. 28, 1913. On shed, Southbridge, Mass.

Cabbage "worm"—Chadborn, N. C. Sept. 28, 1925.

Cabbage Butterfly—Chadborn, N. C. Sept. 28, 1925.

Stable fly (*Stomoxys calcitrans*) on cow, Chadborn, N. C. Sept. 28, 1925.

In my collection is a specimen taken feeding on a horse fly (*Tabanus lasiopthalmus*) which I saw just after the capture. And I have also taken one with a species of *Lestes*.

The other common yellow-jackets occurring in this region—*i.e.*, *V. vidua*, *V. diabolica* and *V. pennsylvanica* (?)[3] I have not seen capture insects, although most of them probably do. Mr. Davis[4] records *Vespa vidua* feeding on a damsel fly and *V. carolina* on an asilid fly.

A word in regard to collecting vespids. These wasps should be killed in alcohol (commercial strength) rather than in cyanide bottles. The alcohol fixes the yellow or white colors which very frequently discolor or turn darker where cyanide is used. The specimens may be left in the spirits for a couple of days before being removed and pinned.

In concluding, I again repeat that there is yet a great deal of interest to be learned regarding wasps and hornets if one wishes to brave their stings and study their habits in the field.

Note. This paper was given at the November 18, 1930 meeting of the New York Entomological Society.

[3] *Vespa vulgaris* L.

[4] Bulletin of the Brooklyn Entomological Society, XIV, p. 121, 1919.

MOROCCAN FOLDED-WINGED WASPS, MAINLY COLLECTED BY PROFESSOR T. D. A. COCKERELL'S PARTY

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During August, 1930, Professor T. D. A. Cockerell (T. D. A. C.), Mrs. W. P. Cockerell (W. P. C.) and Miss Alice Mackie (A. M.) collected in northern and central Morocco twenty-eight specimens of Diploptera representing fifteen distinct forms, which are listed below. I have added a few Moroccan records from my collection, based mostly upon specimens obtained by Professor W. M. Wheeler (W. M. W.) in May, 1925.

The localities mentioned are:

Amizmiz, about 1,000 m., lower slopes of High Atlas, south of Marrakesh.

Ank-el-Djenel (not located on the map).

Asni (High Atlas), south of Marrakesh, 1,245 m. Zone of Olives.

Azrou, about 1,500 m., middle Atlas, southeast of Meknes.

Ifrane, south of Meknes (Middle Atlas), in zone of *Quercus Ilex* and *Cedrus atlantica*.

Mahiridja, about 50 miles southwest of Taza.

Mamora (Forest of), sandy cork-oak forest, near Rabat

Marrakesh, in the semi-desertic region of central Morocco.

Pont des Espagnols, near Casablanca, on the western coast.

Rabat, on the northwestern coast.

Tangier, on the northern coast.

Tinitine, up the valley above Asni, not far from the base of Mt. Toubkal (the highest peak of North Africa).

Masaridinæ

Morocco appears to be unusually rich in masarid wasps, although most of the species are taken only in small numbers. In addition to those listed below, Meade-Waldo and Dusmet have recorded *Ceramius fonscolombei* Latreille, *Paraceramius lusitanicus* (Klug), *Quartinia dilecta* Gribodo, *Q. kohli* Dusmet, *Q. major* Kohl, and *Celonites abbreviatus* (Villers).

Masaris vespiformis Fabricius

At the Paris Museum I have seen one female from Ank-el-Djenel, June 1, 1921 (Powell Coll.), but the species has been previously recorded from Morocco. It is known from Algeria and, in the subspecies *aegyptiaca* Meade-Waldo, from Egypt and Palestine. It has never been found on the European side of the Mediterranean.

Paraceramius spiricornis (H. de Saussure)

Amizmiz, one female, May 30 (W. M. W.).

Previously recorded from Morocco and known also from Spain and Southern France. I have a female from Algeria (Orleansville).

The Amizmiz female agrees with André's detailed description of the color markings, based upon a specimen of unknown locality. Dusmet (1917, Mem. Soc. Esp. Hist. Nat., VIII, 9, p. 383) claims that *spiricornis* is not specifically distinct from *P. lusitanicus* (Klug). A comparison of the specimen from Amizmiz with a female of *P. lusitanicus* from the Sierra de Guadarrama, Spain (identified by Dusmet), discloses several important structural differences: (1) In *spiricornis* the free, anterior plate of the clypeus is about one and one-third times as wide at the apex as long; whereas in *lusitanicus* it is distinctly shorter and wider (over one and one-half times as wide at the apex as long). (2) The sculpture of head and thorax is much coarser in *spiricornis*, the difference being especially striking on the scutellum. (3) The scutellum of *spiricornis* is moderately swollen, with only a slightly raised median ridge; in *lusitanicus* it is very strongly convex, with a well-marked median, elongate hump. (4) The middle and hind femora and tibiæ are more strongly flattened in *spiricornis*, and these tibiæ show a decided longitudinal depression or groove on the outer surface; in *lusitanicus* this depression is scarcely indicated. I may add that the female of *P. hispanicus* (Dusmet) also is structurally quite distinct from either *spiricornis* or *lusitanicus*. All three species should be placed in *Paraceramius*, since they have the eyes deeply emarginate and the middle tibiæ with a single apical spur.

Jugurtia oraniensis (Lepeletier)

Asni, Aug. 6, 7 and 12, three females and one male (T. D. A. C. and W. P. C.). Mahiridja, two females.

True *J. oraniensis* is known with certainty only from Morocco and western Algeria (Oran; Ain Sefra). It is characterized in the female by the shape of the clypeus, which is broadly and deeply emarginate at apex, ending in two rounded teeth. The specimens from Spain, referred by Dusmet to *oraniensis*, belong to a different species, which should be called *J. dispar* (Dufour). H. de Saussure, Ed. André and Dusmet all have synonymized *dispar* with *oraniensis*. Yet the female of the Spanish wasp is at once separated from the North African species by the shape of the clypeus, which has the apical margin trilobed, the median lobe being, however, much shorter than the two lateral lobes. In the male, the seventh tergite is deeply notched at the apex in *J. dispar*, whereas it is only slightly emarginate in *J. oraniensis*. I also regard *J. numida* H. de Saussure as a valid species on structural characters.

Celonites afer Lepeletier

(*Celonites fischeri* of authors, not Spinola)

Asni, Aug. 9, one female, at flowers of *Echium* (T. D. A. C.).

As R. du Buysson (1908, Rev. d'Ent., XXVII, pp. 103–104) has pointed out, there has been much confusion regarding the identity of *C. fischeri* and *C. afer*.

The true *C. fischeri* Spinola was known thus far only from Egypt; but a male from Jericho, Palestine, received from Dr. Enslin as "*C. afer*," appears to be *fischeri*, since it has the seventh tergite trilobed, with the median lobe entire.

All the published records of "*C. fischeri*" from Algeria (E. Saunders), Morocco (Meade-Waldo) and Spain (Dusmet) refer to *C. afer*, which is known from Morocco, Algeria, Tunis, Tripoli, Spain, southern France and southern Switzerland (one male from Sierre, Wallis, in my collection). In the male of *afer* the seventh tergite ends in four lobes (the median lobe being bifid).

Eumeninæ

Eumenes pomiformis var. mediterraneus Kriechbaumer

Asni, two males, Aug. 12 (W. P. C.; T. D. A. C.). Tinitine, one female, Aug. 10 (A. M.). Marrakesh, two males, May 27 (W. M. W.). Pont des Espagnols, one female (W. M. W.).

This form is widely distributed throughout the Mediterranean Subregion. I have seen it also from Algeria, Egypt and Greece.

Eumenes pomiformis var. andrei Dalla Torre

(*Eumenes obscurus* André)

Tinitine, one male, Aug. 10 (A. M.). Rabat one male, Aug. 22 (W. P. C.). Forest of Mamora, one male (W. M. W.). Tangier, one female.

Likewise widely distributed in the countries bordering the Mediterranean. I have seen it from Spain.

The above two forms are color variants of the very variable *E. pomiformis* (Fabricius), of Central and Southern Europe, which I regard as specifically distinct from *E. coarctatus* (Linnaeus). The puncturation of the second abdominal tergite is much coarser in *pomiformis* than in *coarctatus*, differing hardly from that of the first; whereas in *coarctatus* it is fine and contrasts strongly with the coarse sculpture of the first tergite.

Eumenes picteti H. de Saussure

Asni, one female, Aug. 12 (W. P. C.).

I can find no previous Moroccan record of this wasp, which was originally described from Southern France (Montpellier), but occurs also in Algeria (Biskra) and Spain (not only in Spain as Dusmet states, evidently following Ed. André).

Although I have seen no specimen from southern Europe, I feel fairly certain about my identification. Unfortunately some of the most important structural characters of the species have not been mentioned thus far. André's drawing of the petiole is certainly erroneous and, though de Saussure's original figure of the male is recognizable, it disagrees in some respects with the Moroccan female, which has the thorax much shorter and more distinctly widened anteriorly and the narrowed basal portion of the second abdominal segment longer. Clypeus and

tegulæ are coarsely punctured; the first abdominal segment, or petiole, is about one and one-half times as long as the thorax, evenly curved in profile, the narrow basal third gradually widened posteriorly, the apical two-thirds parallel-sided, the dorsal face distinctly flattened and with an elongate-oval, rather shallow depression before the apex; petiole with very scattered, fine punctures, the remainder of the abdomen impunctate. Since the mesopleura are without epicnemial carinæ anteriorly as well as posteriorly, and the apex of the second tergite is simple and smooth, while the male antenna ends in a hook, *E. picteti* should, at least provisionally, be placed in the subgenus *Delta* H. de Saussure, as I have defined it in 1926 (Ann. South Afric. Mus., XXIII, p. 487).

E. picteti is, however, undoubtedly related to *E. leptogaster* F. Walker, of Arabia, which differs in the longer basal stalk of the second tergite. As I have pointed out before, these very slender, small species of *Eumenes* form a natural subgeneric group, for which the name *Ischnogasteroides* Magretti might be available. The type of Magretti's genus should, however, first be studied carefully. *Eumenes tenuis* F. Morawitz, of Transcaspia, and *E. lenis* Bingham, of Burma, also appear to belong in the same group, although the descriptions do not mention the shape of the apex of the second tergite. F. Morawitz also suggests that his *E. tenuis* might belong to *Ischnogasteroides*.

Ancistrocerus blanchardianus (de Saussure)

Asni, one female, Aug. 8 (T. D. A. C.). Marrakesh, one male, May 27 (W. M. W.).

Previously recorded from Morocco by Dusmet and also known from Algeria. The transverse carina of the first abdominal tergite is sufficiently well-marked to place this species in *Ancistrocerus;* the poor visibility of the carina is mainly due to the yellow color of the sides of the tergite. The species is characterized in both sexes by the unusually broad clypeus, which is coarsely punctate and ends in two widely separated, sharp teeth.

Ancistrocerus parietum (Linnaeus)

Tinitine, one female, Aug. 10 (A. M.). Rabat, one male, Aug. 5, at flowers of *Solanum* (T. D. A. C.). Both specimens have

only the first three abdominal tergites marked with yellow and are similar to the more common color form of Central Europe.

Dusmet has recorded this species from Morocco. It is common throughout the Palearctic Region and has been introduced by man into the eastern United States.

Odynerus crenatus Lepeletier

Asni, two males, Aug. 7 (A. M.) and Aug. 8 (T. D. A. C.).

Widely distributed throughout the Mediterranean Subregion. I have seen it also from Spain, Sardinia, Greece, Roumania, Tunisia and Algeria, and Dusmet has previously recorded it from Morocco. It is surprising that E. Saunders did not list it among the wasps taken by Eaton and Morice in Algeria, since I have taken a male at Biskra and I have another from Laghouat.

The several species of the *simplex* group have long been defined almost entirely by the color markings, which, as Dusmet has pointed out, are often variable. Even A. v. Schulthess' recent revision of this group (1928, Eos, IV, pp. 69–79 and 406–410), although extremely valuable, relies to a large extent upon color. Some, at least, of the forms are well characterized by structural peculiarities. For instance, the female of *O. crenatus* may be recognized by the clypeus being about as long as wide and covered with scattering, moderately strong punctures, and by the shape of the upper median area of the propodeum, which is triangular, smooth and shiny.

Odynerus tripunctatus (Fabricius)

Ifrane, one male, Aug. 28 (W. P. C.).

Previously recorded from Morocco by Dusmet, and known also from Algeria and Spain. Ed. André placed this species in his *simplex* group, and Dusmet evidently followed him. The male from Morocco, however, does not have the superior ridges of the propodeum strongly raised and separated by a deep notch from the sides of the postscutellum. The structure of the propodeum places *O. tripunctatus* in the *dantici* group and separates it at once from *O. stigma* (Fabricius).

Odynerus dantici (Rossi)

Ifrane, one female, Aug. 29 (W. P. C.).

Previously recorded by Dusmet from Morocco, and widely distributed in Southern Europe and North Africa. I have seen it also from Spain, Greece and Algeria.

Odynerus parvulus Lepeletier

Asni, one male, Aug. 10 (T. D. A. C.).

Recorded from Morocco by Dusmet and widely distributed throughout the Mediterranean Subregion. I have seen it also from Spain, Greece and Algeria.

Polistinæ

Polistes semenowi F. Morawitz

Asni, Aug. 15, one male (A. M.). Amizmiz, two females (W. M. W.).

This peculiar species, though colored like the common *P. gallicus* and its allies, is easily told in both sexes by the shape of the head and the grooved mandibles. It occurs throughout southern Europe and extends eastward into Persia. I have found no previous record from Morocco.

Polistes kohli Dalla Torre

(*Polistes dubius* Kohl, 1898; not of de Saussure, 1867)

Asni, Aug. 11, one male (W. P. C.). Tinitine, Aug. 10, one female (A. M.). Rabat, Aug. 22, one female (T. D. A. C.).

This species occurs throughout the Mediterranean Subregion. Dusmet has recorded it from Morocco.

Vespinæ

Vespula germanica (Fabricius)

Asni, Aug. 6, six workers (T. D. A. C.; W. P. C.; A. M.). Azrou, three females (W. M. W.).

A common Palearctic species, recorded previously from Morocco and occurring also in Algeria.

Vespula (Dolichovespula) sylvestris (Scopoli)

Ifrane, Aug. 29, one male (T. D. A. C.).

This appears to be the first record of this wasp from North Africa. It is common throughout Europe, also in Spain. I have compared the genitalia of the Moroccan male with those of specimens from Germany and France.

LEAFHOPPERS OF MT. MARCY AND MT. MACINTYRE, ESSEX CO., NEW YORK (HOMOPTERA, CICADELLIDÆ)

By John L. Buys
St. Lawrence University, Canton, N. Y.

Mt. Marcy and Mt. MacIntyre, with respective altitudes of 5344 and 5112 feet, are the highest mountains of the Adirondacks. In fact Mt. Marcy is one of the three highest mountains in eastern North America, Mt. Mitchell in the Southern Appalachians with an altitude of 6711 feet, and Mt. Washington of the White Mountains with an altitude of 6279 feet, being the other two. On the summit of each of these Adirondack peaks there is much vegetation consisting of plants which are distinctly alpine and which form a habitat of considerable interest to the entomologist. Twenty-three distinctly alpine species of plants are recorded* from the summit of Mt. Marcy and about as many occur on Mt. MacIntyre. The following are characteristic species found on both mountains: bearberry willow (*Salix Uva-ursi*). glandular birch (*Betula glandulosa*), black crowberry (*Empetrum nigrum*), Diapensia (*Diapensia lapponica*), Lapland rose-bay (*Rhododendron lapponicum*), Cutler's alpine goldenrod (*Solidago Cutleri*), low rattlesnake root (*Nabalus nanus*), and bog bilberry (*Vaccinium uliginosum*). Besides these there are several species which may be either alpine or encroachments from the lower altitudes and there are many which are definitely plants of lower altitudes that have become established here. On Mt. MacIntyre especially there is much sphagnum, Labrador tea, and other characteristic bog plants. Many of the depressions of these summits are filled with a scrubby growth of black spruce (*Picea mariana*), glandular birch (*Betula glandulosa*), and balsam (*Abies balsamea*). The bearberry willow (*Salix Uva-ursi*) and the bog bilberry (*Vaccinium uliginosum*) are very plentiful, forming dense beds of shrubs.

* Plants and Animals of Mount Marcy, New York, by C. C. Adams, G. P. Burns, T. L. Hankinson, B. Moore, and N. Taylor. Ecology, vol. 1, no. 2, p. 71–94; no. 3, p. 204–233; no. 4, p. 274–288, 1920.

The climate is rather severe at these altitudes. It is said that Marcy is hardly more than two months without snow and it is likely that this applies to MacIntyre also. In the paper by Adams previously referred to it is stated that the growing season around Marcy's summit averages about ninety-two days. The latest frost reported is July 20 and the earliest, August 18, not in the same year. Little accurate information is available concerning temperatures but from personal observations it can be said that it is nearly always cool and sometimes very cold during the collecting season for leafhoppers. The strong winds and high pprecipitation often make sweeping with an insect net difficult and the generally low temperatures do not make collecting any easier.

Except for a few families of flies, leafhoppers seem to be the most abundantly represented group of insects. Eighteen species of this family were collected from the summit of Marcy and thirteen species from MacIntyre. Besides these, *Deltocephalus sayi* is reported from Mt. Marcy by Adams but was not collected by the writer. The collections were made from Marcy on August 20, 1930, and from MacIntyre on July 26, 1930. Because of weather conditions the collecting on MacIntyre was not so extensive as on Marcy. Both collections were made around the summit distinctly above the so-called timber line. Two attempts have been made to collect leafhoppers on MacIntyre in early June but snow and strong winds at the summit made it impossible each time.

LEAFHOPPERS FROM MT. MARCY

1. *Idiocerus suturalis* var. *suturalis* Fitch. 3 specimens.
2. *Draeculacephala mollipes* (Say). 1 specimen.
3. **Deltocephalus apicatus* Osb. 1 specimen.
4. *Deltocephalus inimicus* (Say). 1 specimen.
5. *Deltocephalus melsheimerii* (Fitch). 1 specimen.
6. *Deltocephalus sayi* (Fitch). Not collected but reported from Mt. Marcy by Adams.

* Several of the subgenera of Deltocephalus have been given generic rank by DeLong and Sleesman, Ann. Ent. Soc. Amer., vol. 22, no. 1, p. 81–114, 1929.

7. *Thamnotettix stramineus* S. & De L. 1 specimen. Not previously recorded from New York. Also collected in vicinity of Canton, N. Y.
8. *Cicadula sexnotata* (Fall.). Many specimens. Very abundant.
9. *Balclutha punctata* (Thunb.). 1 specimen.
10. *Balclutha impicta* (Van D.). 4 specimens.
11. *Eugnathodus abdominalis* (Van D.). 1 specimen.
12. *Empoasca fabæ* (Harr.). Many specimens.
13. *Deltocephalus misellus* Ball. 4 specimens. Previously reported from high elevations and apparently a northern species.
14. *Deltocephalus striatus* (L.). 1 specimen. Reported under *D. affinis* from Mt. Marcy by Adams. Reported from Alaska as well as from many parts of the United States and Canada.
15. *Ophiola angustata* (Osb.). 4 specimens. Described from Mt. Katahdin, Me., at elevations up to 4700 feet. Also reported from low ground at Cranberry Lake, N. Y.
16. *Ophiola arctostaphyli* (Ball). Many specimens. Very abundant. Described from high altitudes (7000–9000 feet) in Colorado, collected on bearberry (*Arctostaphylos Uva-ursi*). Reported from mountains in Maine (4700–5000 feet) and from Mt. Washington, N. H. A definitely alpine species.
17. *Ophiola cornicula* (Marsh.). 1 specimen. Reported from mountains in Maine. Also occurs in low places. Probably feeds on heath plants.
18. *Ophiola osborni* Ball. 2 specimens. Reported from dry uplands in northeastern United States.
19. *Cicadula slossoni* Van D. 3 specimens. Reported from Mt. Katahdin, Me., at 4500–5300 feet and from Mt. Washington, N. H. It also occurs in other situations.

LEAFHOPPERS FROM MT. MACINTYRE

1. *Agallia sanguinolenta* (Prov.). 1 specimen.
2. *Oncopsis pruni* (Prov.). Many specimens. Very abundant. Also collected on the MacIntyre trail from yellow

birch (*Betula alba* var. *cordifolia*). Reported from Mt. Katahdin, Me., at 4500 feet. A widely distributed species.

3. *Deltocephalus acus* S. & De L. 1 specimen.
4. *Deltocephalus inimicus* (Say). 1 specimen.
5. *Deltocephalus melsheimerii* (Fitch). 1 specimen.
6. *Deltocephalus pascuellus* (Fall.). 2 specimens.
7. *Dikraneura fieberi* (Loew). 4 specimens.
8. *Deltocephalus paludosus* Ball. 3 specimens. Previously reported only from Colorado. Possibly an alpine species.
9. *Deltocephalus misellus* Ball. 5 specimens.
10. *Ophiola angustata* (Osb.). 6 specimens.
11. *Ophiola arctostaphyli* (Ball). Many specimens, both nymphs and adults. Very abundant.
12. *Ophiola osborni* Ball. 1 specimen.
13. *Cicadula slossoni* Van D. Many specimens. Very abundant.

In addition to the above named species many specimens of the genus *Typhlocyba* were collected from both mountain tops and along the trail up Mt. MacIntyre. All but one of these are females; hence their identity is uncertain. None of them has color markings on the cross veins, a feature generally characteristic of *T. gillettei* Van D. The male, however, although it has no color markings above, has the genitalia of *T. gillettei* and has been so identified by W. L. McAtee. This is a widely distributed species.

The purpose of this study is two-fold: first, to find out what species of leafhoppers live on the summits of these mountains; and second, to learn whether any of these species are limited in their distribution to the tops of high mountains. The list of species answers the first question, although undoubtedly more names will be added to this list as more collecting is done.

In answering the second question one must take into consideration the fact that many leafhoppers living in the surrounding lower altitudes may gradually make their way up the mountain, possibly aided by strong winds. Some of these species have been able to breed here while others have been unable to withstand the severe conditions and are represented only by stray individuals. To this category of species that have a wide distribu-

tion or are more commonly found at lower altitudes belong the first twelve of the Marcy list and the first seven of the MacIntyre list. Of these *Cicadula sexnotata* seems to be well established and without doubt breeds on Mt. Marcy, while *Oncopsis pruni* is certainly well established on Mt. MacIntyre and was collected in numbers from yellow birch (*Betula alba* var. *cordifolia*) along the trail up this mountain.

For a few species the environment on mountain tops is a natural one either because of suitable temperatures or because their host plants, generally bog species, grow abundantly in these places. The remaining species of both lists (13–19 from Marcy and 8–13 from MacIntyre) may be considered as belonging to this group since all of them have been recorded previously from mountain tops or places having a fair altitude. Most of them, however, have also been collected from lower regions. This is especially true of species which feed on bog plants. *Ophiola arctostaphyli* is the most abundant species of leafhopper on these summits and is the most definitely alpine form. *Deltocephalus paludosus* may possibly be a definitely alpine form also. It has been recorded heretofore only from Colorado.

EFFECT OF CERTAIN RADIO WAVES ON INSECTS AFFECTING CERTAIN STORED PRODUCTS*

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INTRODUCTION

Headlee and Burdette (1) have shown that when certain representatives of the Hymenoptera, Diptera, Coleoptera, Lepidoptera and Orthoptera orders are subjected to radio waves promulgated in an electro-static field at a frequency of 12,000,000 cycles per second and an amperage of 1¾ amperes they are destroyed. In the honey bee they have shown that this destruction was due to the production of internal heat of a lethal degree. In the same insect they have also shown that the rate of producing this internal heat seems to be in part connected with nervous reaction. The intensity or field strength of the electrostatic field used by these workers has since been determined. For *Apis mellifera* it is 1,585 volts per linear inch, for *Glypta* 1,410, for *Musca domestica* and *Diabrotica 12-punctata* 1,570, and for *Pieris rapae* and *Periplaneta germanica* it was 1,410. Headlee (2) has shown that the principal variable physical factors underlying these lethal effects are apparently field strength, which is commonly expressed in terms of volts per linear inch, and frequency, measured in terms of cycles per second, that the optimum frequency for insects falls between 1,000,000 and 3,000,000 cycles per second at a field strength of about 4,000 volts per linear inch, and that there seems to exist a very considerable margin of safety between the power necessary to kill insects promptly and the power which will do damage to plants.

EFFECT ON INSECTS AFFECTING DRY FIGS, APRICOTS, PEPPER AND OTHERS

Having in mind the data set forth in the above discussion we proceeded to the study of the effect of high frequency radio

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** Fellow 1928–29 and 1929–30.

waves on insects affecting stored products. Although the main object of this study is to show the effect of these radio waves on bean weevils, some data on the effect on some other insects will be given below. Between the aluminum test plates a glass tube four inches long and one half inch in diameter was suspended. The chemical composition of the glass as given by the manufacturer was the following.

AL_2O_3	2.0
Fe_2O_3	0.25
MnO	0.01
CaO	0.29
MgO	0.06
Na_2O	4.4
K_2O	0.2
SiO_2	80.5
B_2O_3	11.8
As_2O_5	0.7

The results are shown in table 1.

TABLE 1

Insect	Frequency in Cycles Per Second	Strength of Field in Volts Per Inch	No. of Runs	No. of Insects	Time to Kill in Minutes
Plodia interpunctella Naked larvæ	1,090,000	3977.16	10	30	0 –35″
Plodia interpunctella Larvæ in the fig	1,090,000	3977.16	10	30	2′–30″
Carpocapsa saltitans Mexican Jumping beans) Naked larvæ	1,090,000	3977.16	3	9	1′– 5″
Carpocapsa saltitans Larvæ in the beans	1,090,000	3977.16	6	18	3′– 0″
Sitodrepa panicea	1,090,000	3977.16			
Larvæ			10	30	1′–30″
Pupæ			10	30	2′– 0″
Popillia japonica Grubs in the soil	1,090,000	3977.16	10	30	3′–30″

This table shows that insects affecting stored products are killed when subjected to high frequency radio waves. Larvæ of *Plodia interpunctella* affecting dry figs, apricots, etc., and larvæ and pupæ of *Sitrodrepa panicea* affecting ground pepper are killed when subjected to these waves for a period of time ranging from two minutes to two minutes and thirty seconds.

EFFECT ON BEAN WEEVILS, BRUCHUS 4–MACULATUS FAB.

Bruchus 4-maculatus Fab., belongs to the family Bruchidæ of the order Coleoptera. The weevils are very short and robust measuring about ⅛ inch in length. The color is usually dark gray. The eggs are very small and white in color. The grubs are of a light creamy color and very small, a number of them being able to occupy a single bean. The pupæ are darker in color. The beetles under favorable conditions breed in stored beans over winter and in the springtime when the plant beans are in bloom, they fly and lay their eggs upon the pods. Upon hatching the young larvæ bore through the pod, reach the beans and then enter into them by drilling a hole which is very small to be easily distinguished. In the store the beetles lay their eggs singly on the beans. When the insects reach the adult stage they cut circular holes and emerge.

There are many generations each year. The beetles under favorable conditions breed enormously in the stored beans and render them altogether unfit for food or planting. Some times the embryo is devoured and the seeds do not germinate at all. Some times the cotyledons are devoured and the young embryo has not the necessary nutritious elements to grow until the plant will form its roots and become self-supporting.

It is of primary importance therefore to plant healthy seeds, free from any infection of bean weevils.

A complete line on the effect of high frequency radio waves on bean weevils and the possibility of a successful treatment of infested beans was worked out. Beans heavily infested with the bean weevil (*Bruchus 4-maculatus* Fab.) were obtained. Eggs, larvæ, pupæ and adults were present at the same time. A number of lots, 25 beans each were put one after another in a glass tube and subjected to high frequency waves for 2, 3, 4,

and 5 minutes respectively. One lot of 25 beans was left untreated to serve as a check.

These beans were put in small bottles and placed in the incubator with a constant temperature of 82° F. and moisture of 73 per cent. They were left in there from the twenty-first of October to the twenty-eighth of November, that is to say for a period of 38 days. In that period of time we could have a complete life cycle of the insect. Observations were made twice a day; all the emerging insects were recorded and taken out of the bottles.

Table 2 shows the results.

TABLE 2

No. of Days from Treatment to Examination	Numbers of emerged adults				
	Untreated Check	Treated for 2 minutes	Treated for 3 minutes	Treated for 4 minutes	Treated for 5 minutes
7	2		...	..	...
11	3	2	..	...	...
12	2	1	...	...	...
14	2	1	1	...	...
15	3	.	...	...	...
16	3	1	.	..	.
17	3	1	...	...	...
18	4	3	..	1	...
19	8	...	2	..	...
21	4	1	...	...	...
22	3	3	2	.	...
23	1		1	...	...
24	....	2	...	1	...
25	2	.....	...	1	...
26	1	. .		...	...
28	1	.	1	...	...
30	1	....	...	...	...
33	2	3	1	...	..
35	1	1	...	...	...
36	......	. .	...	...	...
38	......	....	...	...	...
Total Emergence	46	19	8	3	0

Examination of this table serves to show that all stages of the bean weevils are killed when the beans are subjected to a frequency of 1,087,000 cycles per second for five minutes with a strength of field of 4,000 volts per linear inch.

EFFECT ON SEED

The next step was to find out if the seeds thus treated lost their vitality or not. A variety of seeds, which usually are attacked by bean weevils or other similar insects, were treated for from two minutes up to 45 minutes. A set of five seeds of each of the following varieties except *Lentilla lens* (where a set consisted of 10 examples) was employed for each time period. After that they were planted in pots in the greenhouse. The seeds thus treated were: *Vicia faba* (Egyptian beans); *Phaseobus vulgaris* (common beans); *Phaseobus dolichus* (black eye bean); and *Lentilla lens* (lentils).

The seeds were put in glass tubes and suspended between the aluminum test plates. They were subjected to the radio waves for a time ranging from two to forty-five minutes. On the same day of the treatment the seeds were planted in pots and placed in the greenhouse. After a few days the seeds germinated to the proportion of 100 per cent. giving up perfectly healthy plants just as the untreated seeds did. Table 3 shows the results.

TABLE 3

Kinds of Seeds	No. of Seeds in Each Set	Treatment Time in Minutes for Each Set	Days Between Treatment and Coming Up	Per cent. Germination
Vicia faba	5	2, 3, 4, 5, 10, 20, 30, 35, 40, 45	5	100
Phaseobus vulgaris	5	5, 10, 15, 30, 45	5	100
Phaseobus dolichus	5	5, 10, 15, 30, 45	5	100
Lentilla lens	10	2, 3, 4, 5, 10, 15, 20, 25, 30, 35, 40, 45	4	100

The bean weevils are killed when subjected to these radio waves for five minutes. The seeds are not destroyed even if they be subjected for 45 minutes or more. The heat accumulated in the insects is great enough to kill eggs, larvæ, pupæ and adults of *Bruchus 4-maculatus* but in the plants not high enough to damage the embryo of the seed.

CONCLUSIONS

The following conclusions may be drawn from the data submitted.

1. Certain insects subjected to high frequency radio waves are killed on account of the internal temperature which reaches a lethal point.

2. Larvæ of *Plodia interpunctella* affecting dry figs, apricots, etc., and larvæ and pupa of *Sitrodrepa panicea* affecting ground pepper are killed when subjected to these waves for a period of time ranging from two minutes to two minutes and thirty seconds.

3. All stages of the bean weevil (*Bruchus 4-maculatus* Fab.) are destroyed when subjected for five minutes to a frequency of 1,087,000 cycles per second with a field strength of 4000 volts per linear inch.

4. Treated seeds do not lose their germinating power. They may be planted and thus the damage due to infestation is eliminated.

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NOTES ON SOME NATURAL ENEMIES OF THE MOSQUITO IN COLORADO

BY SHERMAN C. BISHOP AND RICHARD C. HART*

In the course of some biological field work in the San Luis valley in Colorado, some predacious enemies of the mosquito were encountered which seem to have escaped notice.† The observations here recorded were made during June and early July 1930, the season of maximum abundance for several species of *Aedes*.

The San Luis valley lies in south central Colorado between the Sangre de Cristo and Culebra mountains on the east and the San Juan mountains of the Continental Divide on the west. The valley has an average elevation of 7500 feet, a north and south extent of 110 miles and an extreme width of about 60 miles. It is a broad, level plain, apparently the bed of an extinct lake, and dry except where irrigated and in the vicinity of the lakes and streams. The Rio Grande is the most important stream in the valley and provides much of the water used in irrigation.

Standing water is limited to the few small lakes scattered over the floor of the valley, to the abandoned ox-bows and sloughs of the Rio Grande and to certain sloughs which derive their water by seepage or overflow from irrigated meadows and fields. Where water stands throughout the year, the natural enemies of the mosquitoes keep them at least partially under control. Dragon flies are present but less numerous than the apparently favorable conditions would lead one to expect. Dytiscid beetle larvæ, notonectids and gerrids are abundant. Among the vertebrate predators may be mentioned several small fishes, a frog, *Rana pipiens*, a cricket frog, *Pseudacris*, a toad, *Bufo*, and the larva of the Tiger salamander, *Ambystoma tigrinum*.

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† Howard, Dyar and Knab in, The Mosquitoes of North and Central America and the West Indies, 1:170, 1912, record the capture, in Panama, of mosquito larvae by flies of the family Dolichopodidae but the species involved were not determined.

Temporary waters offer a more serious problem because of their great extent. On the irrigated native-hay meadows and on fields given over to crops of various kinds where flood irrigation is practiced, water stands from a few days to three or four weeks, creating ideal breeding places for mosquitoes over thousands of acres. In such situations the aquatic enemies of mosquitoes do not become sufficiently well established to be effective. Two of the predators to be mentioned are of interest because they are found not only about the more permanent waters but at pools of the most ephemeral character if these are sheltered from strong winds.

In a small gravel pit which derived its water by seepage or overflow from an adjacent hay meadow, mosquito larvæ were extremely abundant. While collecting at this pool our attention was caught by a number of small, metallic-green flies that drifted lightly over the surface of the water or ran rapidly from one resting place to another. On the surface of the pool, the flies were observed to turn first in one direction then another without discernable movement of the legs or wings, though the turns seemed well directed and often placed them in position above a mosquito larva or pupa at the surface film. Such movements on the part of the flies often caused a precipitous retreat of all the larvæ in the vicinity but seldom quickly enough to prevent one of their number being seized and hoisted squirming above the surface. Usually the captive was devoured on the spot, but at times carried away bodily to some convenient perch. After observing the capture of larvæ in the field, a number of the flies were confined with larvæ and pupæ in a cheese-cloth-covered jar partially filled with water. Here the hunting operations could be observed at short range and we saw several captures. The fly in captivity either glided over the surface or suddenly pounced down upon a larva and continued in its flight to a resting place, the mouthparts of the fly alone being involved in seizing the larva.

On the morning of June 27 we placed twelve larvæ and two pupæ in a jar with two flies. During the day two mosquitoes emerged from their pupal skins and were found dead on the sur-

face of the water and by the following morning nine of the twelve larvæ had been devoured. Two of the remaining larvæ were taken soon after. In the afternoon twenty additional larvæ were provided. During the following day the two flies accounted for the twenty larvæ and were actively hunting for more. On the afternoon of June 30, twenty larvæ and two additional flies were placed in the jar and the four flies captured sixteen larvæ in a period of two and three-quarters hours and the balance before the morning of July 1. During the day (July 1) two of the flies fell into the water and failed to survive the wetting, but the two remaining captured twenty-one larvæ by the morning of July 2. Twenty-five larvæ added in the afternoon of July 2 were reduced in number to ten on July 3 and five on July 4, when the experiment was discontinued. Thus ninety-three larvæ were accounted for in a period of seven days, mostly by two small flies. This record, perhaps, does not compare very favorably with that of certain dytiscid beetle larvæ, individuals of which have been known to kill several hundred larvæ in such a period, but it does add to the known enemies of the mosquito some active little flies that as adults prey on both larvæ and pupæ.

The flies captured while feeding at the surface of the pool were kindly determined for us by Dr. A. O. Johaansen, of Cornell University, as *Dolichopus renidescens* M. and B., *D. nigricauda* M. C. A., *D. appendiculatus* M. C. A., and *D. walkeri* M. C. A. *D. walkeri* was apparently the most abundant species and was the one involved in the laboratory experiment.

The same little pool provided excellent hunting for a considerable number of small lycosid spiders which, like the flies, ran freely over the surface of the water but unlike them did not succumb to a wetting. Often, in fact, they ran down a grass stem to hide below the surface, and thus thwarted our attempts to capture them. The spiders in their hunting quietly anchored themselves by one foot to a floating bit of débris, or sallied forth from the shelter of the marginal vegetation. Again like the flies, the spiders took both larvæ and pupæ and, in addition, adults as they emerged.

Observations in the field were checked by experiments under artificial conditions. During the morning of June 27, twelve larvæ and five pupæ were placed in a half-filled jar with five spiders. At 4 P. M., on June 28, two larvæ and four spiders remained alive, a male spider having proved an acceptable bit to one of the larger females. Ten larvæ were added at 4 P. M., on June 28 and of these nine were eaten by the following evening. By the morning of June 30, the last larva had been devoured and an additional lot of twenty-five larvæ and five pupæ was added. This lot lasted through July 2 when the experiment was brought to a close with the untimely death of two more spiders, victims of the cannibalistic appetites of their fellows. In this experiment four spiders took fifty-seven larvæ and pupæ in the period between June 27 and July 3.

It is not suggested that these spiders limit themselves to a diet of mosquitoes; they merely take advantage of an abundant and easily available food supply. The snares of many web-building spiders capture adult mosquitoes, but these wandering lycosids seek out and take by strategy the larvæ and pupæ in the pools. The spider is *Pardosa sternalis* (Thorell), a strikingly marked species common in the west.

Two deep roadside ditches separated by the width of a country road furnished much material for observation and some food for speculation. The ditch on the one side had an immense number of developing mosquito larvæ and the phyllopod crustacean *Streptocephalus sealii* Ryder,* while that on the other had few of either, but instead supported a number of pond snails. Dytiscid beetle larvæ, dragon-fly nymphs and other well-known mosquito enemies were present in some numbers in both ditches. The presence of the crustaceans suggested that the one ditch must be dry during a part of the year, for these are creatures of the transient pools and many of their kind were to be found on the temporarily flooded hay meadows. But the many aquatic plants and animals pointed to a condition of more or less permanency and we were forced to the conclusion that the ditch was subjected to drying for a short period following

* Kindly determined for us by Edwin P. Creaser of the Museum of Zoology, University of Michigan.

the draining of the adjacent hay meadows. The same aquatic plants and animals were present in the other ditch but the crustaceans were lacking as they were also lacking in all the ponds and sloughs in the vicinity that were obviously permanent in character.

The presence of the pond snails also gave evidence of the persistence of some water in the one ditch throughout the year, just as their absence in the other supported the view that it was subjected to drying. Mosquitoes breed in both permanent and transient waters where conditions are suitable, but here the natural enemies were apparently equally abundant in both. In our search for the agents responsible for the almost complete control of the mosquitoes in the one ditch, the snails appeared as the only possible factors. We were not in a position to decide as to the ability of snails to capture mosquitoes, our knowledge of their feeding habits being limited to the fact that many were plant feeders and a few carnivorous. An accommodating snail at the surface film promptly settled the question by exhibiting a mosquito larva in its mouth. The snail as an active predator excited our interest at once.

Larvæ identified from specimens taken in the ditch where they were abundant were found to belong to mosquitoes of the genus *Aedes* and it might be argued that they were present because the drying of the ditch presented the opportunity for oviposition in the mud of the bottom. The argument is without weight, however, for variation in the height of water in both ditches frequently exposed muddy banks to which adults were attracted in great numbers. Evidence that mosquitoes had deposited their eggs on the banks of the snail inhabited ditch and that the snails could control the developing larvæ was soon forthcoming. In a narrow roadside pool filled by seepage from the main ditch but cut off from it and from the snails by a ridge of earth, young larvæ were found developing by thousands. The ridge had been thrown up by a road scraper and we improved matters somewhat by deepening it and limiting its length, by means of sods, to about six feet. The average width was perhaps fifteen inches. Into this teeming pool, on June 15,

we placed sixty snails. On June 18 the larvæ had been greatly reduced in numbers and by the afternoon of the following day only about one-eighth of the original number survived. On June 20 only a few larvæ were to be found and these were concentrated in one shrinking puddle. On June 21 to 22 we did not see the pool and by June 23 the open water had disappeared, due to the lowering of the level in the ditch. No larvæ were to be found on the wet mud, however, and it is reasonable to assume that the snails finished the last of them. The snails were all alive and active when restored to the ditch.

In this experiment the snails alone were responsible for the destruction of the larvæ, other natural enemies being entirely eliminated from consideration. But it should be pointed out that due to the relatively low temperature of the water, development of the larvæ was retarded, giving the snails plenty of time to accomplish their work.

Experiments were conducted under laboratory conditions as follows: At 5 o'clock on the afternoon of June 14, seventeen snails and twelve larvæ were placed together in a cloth-covered jar. By the following morning eleven larvæ had been taken and the twelfth disappeared during the day. At 10:15 P. M., of June 15, twenty-five additional larvæ were placed with the original seventeen snails and by 8 o'clock on the morning of the 16th all had been devoured.

Another lot of fifty larvæ presented to nineteen snails on the afternoon of June 16 had completely disappeared by the afternoon of June 20. Individual snails confined in vials were able each to capture from two to six larvæ in twenty-four hours. The snails not only captured the larvæ, but readily accepted them from the point of the forceps.

No proper estimate of the number of mosquitoes taken by snails under natural conditions could be gained by the laboratory experiments because the majority of the snails promptly applied themselves to the side of the jar and remained without moving through the period of confinement. A few more active individuals were therefore entirely responsible for the destruction. After a few days these too went into retirement and could be induced to eat only by scraping them from their positions.

The snails in their feeding cruised slowly about over the aquatic vegetation or clung, inverted, to the surface film. Forced to the surface to breathe, the mosquito larvæ and pupæ continually bumped into the snails and when contact was made with the fleshy parts, they were promptly seized. The snail would even twist and bend itself to seize a larvæ not in position near its mouth. For an animal endowed with such a reputation for slowness, the movements were surprisingly rapid. Viewed from above, the snail when cruising the surface film, could be seen continually opening and closing its mouth, exhibiting an oval opening entirely adequate to accommodate the largest larva.

Having determined that the snails were actively killing larvæ and pupæ of mosquitoes and that they were apparently responsible for the almost entire absence of them in the roadside ditch, we directed our attention to other ponds and pools which were obviously of a permanent character. In every instance where snails were abundant, mosquito larvæ were so few in numbers as to be negligible.

The snail is *Lymnaea palustris* (Muller), widely distributed in Europe and North America and common in many localities. It was determined for us by Dr. Henry A. Pilsbry of the Academy of Natural Sciences of Philadelphia.

THE BEARING OF THE OXYTOFACTOR IN INSECT CONTROL

W. DWIGHT PIERCE

A number of years ago the writer called attention to the Law of Happy Medium of Temperature in its bearing upon insect life. Later he was able to add that there was a happy medium of humidity, pressure, light, atmospheric gases, and acidity-alkalinity.

Acidity-alkalinity is expressed by a logarithmic factor called pH, an expression of the hydrogen ionization, but the writer has chosen to express this factor as the oxytofactor.

The essence of the theory is that each species of animal or plant has its typical soil, its proper environment of all factors, and hence if it is a soil dweller it will respond favorably to a certain range of oxytofactors, and outside of this range at either end of the scale its reaction will be that of anesthesia, while a greater departure will result in death.

We have animals that live in highly acid conditions, and also plants; and on the other hand there are forms found in highly alkaline conditions.

The same thing is true of life in the water and in the air, for there is an oxytofactor to express water or air conditions.

That soil, or water, or air oxytofactor of the environment which is most favorable for the life of a certain species is the typical soil or happy medium as regards the oxytofactors.

Plant and animal life are complex, the animal more than the plant. Each organ in the economy of the creature operates under a typical oxytofactor. So that in the processes of ingestion, assimilation and elimination there are alternating series of oxytoreactions. For example in man the reaction in the mouth is alkaline, in the stomach acid, in the first intestine alkaline, and subsequently acid. These reactions are delicately balanced and it only requires a little excess of certain types of foods to completely overthrow the entire system.

Just as the internal organs have their typical reactions, so also do the surface organs.

Now all of these facts have a decided bearing upon the practises of economic biology, in which I include medicine.

The oxytoreaction is the basic chemical reaction. It is in effect the interchange between two bodies differently electronically charged. In other words no matter what we wish to kill, whether it be a creature on a plant, or in the soil, or in the liquid media, or perhaps within the body of an animal, or man, or in the interior of a plant, if we desire to kill it by bringing about a disintegrating chemical reaction, we must accomplish it by means of an oxytoreaction.

In entomology we kill by chemical reaction, by asphyxiation which in most cases is the same kind of a reaction although it may be a covering up of the breathing apparatus, and by mechanical means. But the greatest portion of our practise is chemical. Until recent years medical practise has largely also been chemical.

There are therefore certain practises and certain principles which if observed will aid materially in the proper solution of problems of control of an undesirable species, organism, plant or animal.

1. The first essential to economic practise is therefore the determination of the typical soil of the organism desired to be destroyed.

2. The second step is the determination of the bounding oxytofactors which merely cause anesthesia, for if we attempt to control by using such factors we have failure.

3. The determination of the limiting oxytofactors for continuation of life. Every organism has its limiting oxytofactors.

4. The determination of the bearing of temperature, humidity, light and pressure upon the practic, anesthetic and fatal zones of oxytofactors. This is imperative. Any one drawing conclusions at a certain temperature-humidity-light-pressure complex, and disregarding the fact that all four of these factors vitally affect reaction and rate of reaction is certain to have trouble when working under another factor complex.

5. Having determined the destructive oxytofactors under the existing other environmental factors it becomes necessary to determine whether you are to use the acid or the alkali fatal oxytofactor.

6. A criterion for this may be found often when you consider the other organism or organisms involved. The purpose of the research is to accomplish the death of certain organisms without injury to certain others. These others may be associates in the same medium, or they may be the hosts whose health is injured by the presence of the organism to be destroyed.

7. Just as the organism to be killed has its practic, anesthetic and fatal zones of all factors, so also does the organism to be saved.

8. As a rule a dependent organism has a more restricted practic zone than its host, and it will usually be found that one of its fatal zones is more favorable to the host than the other. This is the one to be chosen.

9. It will usually be found that the host is only seriously injured when its environment, or the condition of certain of its organs is unfavorable, and hence the indicated direction for treatment is in the direction of normalcy for the entire organism, and all of its organs. In other words a tree may be seriously injured by insects or disease, and another tree of the same kind may be uninjured. In such case there is the possibility that an adjustment of the nutrition of the former will bring about amelioration of the condition, much faster than the destruction of the pest alone, for if you only kill the pest and leave the plant still in a state of improper nourishment it is subject to more damage.

10. Just as a plant can be killed by too much or too little calcium, nitrogen, phosphorus, potash, manganese, magnesium, sodium, iron, sulphur, etc., in the soil, so also can it be made most productive when each of these factors is in the proper ratio. The same thing relates to the functioning of the animal body. Its food elements must be properly balanced, and an excess or deficiency of any food element may be destructive.

11. The insect or other organism feeding at the expense of another living organism, plant or animal has its own boundaries of limiting factors for the food it derives from its host. In other words the welfare of the parasite depends upon the state of health of the host, and it usually happens that the parasite develops best when the host is not in the best health, for if it

were properly functioning in every respect it could throw off its enemies.

12. The host makes an unusual effort to overthrow injurious attack and this wears it down unless it has sufficient resources to tap.

13. A control measure which causes a set back to the host while accomplishing the control of its enemies is undesirable if we can find in another direction a control measure which will be favorable to the host and unfavorable to its enemy.

14. Consequently often the proper control measures are the reconditioning of the environment of the host to enable it to accomplish the destruction of the parasite.

15. A control measure which temporarily accomplishes its purpose of control of the pest, but which leaves residues which will accumulate in subsequent treatments, may become a serious menace not only to the future life of the host that is being protected, but in the case that these residues accumulate in the soil may permanently injure that soil for the growth of future crops. This is one of the greatest dangers in continued use of arsenic, for some plants have a very low tolerance for arsenic in the soil, and the result would ultimately be the impossibility of accomplishing a desirable rotation of crops.

16. It must be remembered that the fertility of soil is to a large extent due to the micro-organisms which bring about the necessary chemical changes. If we use in economic control of pests any substance which in the accumulation of subsequent treatments will tend to destroy the beneficial micro-fauna and flora of the soil, we are solving a present problem and laying up trouble for the future. The responsibility of the economic biologist in whatever branch is not only to the present generation, but also to all future generations.

17. Many tests have already shown that the efficacy of an insecticide depends upon its oxytofactor. Calcium arsenate does not kill just because it is an arsenical, but because it brings about an unfavorable reaction. So too a given strength of nicotine may not kill, and yet the mere alteration of its oxytofactor, without changing the strength may bring immediate results. Does this not to some measure indicate that many substances not

at all considered toxic could be made toxic by a simple change in acidity or alkalinity?

18. Any law proclaiming a substance poisonous merely on the basis of its chemical strength may be an unfair and misleading law. Any board proclaiming that a substance is not a poison may be doing science a great injury. The writer has a personal idiosyncracy against chocolate due to an overdose on one day, so that a small quantity of chocolate acts as a poison although that overdose was taken twenty-five years ago. Many people are poisoned by eggs, some by chicken, some by salt, some by pepper, some by cucumbers, some by tomatoes; are we therefore to declare these things poisons? Or is it fair to say that they are non-toxic? Any substance whatsoever that may accomplish the killing of an organism is a poison to that organism.

19. In some states they claim that calcium is not a fertilizer. They have so limited the political definition of a fertilizer that the law only recognizes nitrogen, phosphorus and potash. This is a positive injury to science. Any chemical necessary for the proper nourishment of a plant is a fertilizer. Often a very slight deficiency of some minor elements in the soil is the cause of plant injury, which makes it more susceptible to disease and pest attack.

20. Economic biological control of pests is not confined to insecticides and fungicides but must also include proper soil treatment.

21. That treatment which accomplishes at the same time the largest number of benefits is the most to be desired. If we can in one treatment use a chemical which, while killing the pest, will also stimulate the plant and do no future injury, we have accomplished a double purpose.

22. Any system of governmental division of functions which makes it impossible for experts to recommend certain treatments because those treatments have been arbitrarily placed under the jurisdiction of some other division is detrimental to the proper rendering of service. If they must be divided in function then there must be such correlation of investigational relations that personal or divisional jealousies cannot prevent the publications of results because not done by the employee of a certain designated governmental branch.

Permit me now to give one or two concrete examples of the above principles from my own practise.

I was called in by a lady in California to bid on the cleaning up of a serious infestation of snails and slugs, which were destroying all of the vegetation on her place. I made a bid, basing it upon the use of arsenical bran bait. She accepted the bid and then said, "I do not want you to use any arsenic, or any bran containing other poison, because my dog and cat will eat bran; and I don't want you to kill any birds. Just destroy the snails and slugs and nothing else." I said, "You have cut me out of my only effective methods, so far known. But I have given my bid, I will take the contract."

I went to the local druggist and said, "Give me samples of every cheap chemical you have on hand." I took these to my laboratory and placed large sheets of paper on the floor and made rings of chemical about a yard wide. Then in the ring were placed many snails and slugs.

A certain series of chemicals caused the snails to become dormant and to seal up their shells. Some remained perfectly dormant for thirty days. For example lime caused a slight suspension of activity; sal soda caused them to encyst for eleven days; ammonium alum kept them in anesthesia for 20 to 30 days after a mere contact; salt caused a suspension of activity in one case of 34 days. Contrary to expectation salt did not kill a single individual of *Helix adspersa*.

Then I found that there were some chemicals which caused death in a few minutes, as copper sulphate and ferrous sulphate. Certain very alkaline chemicals did the same.

The snails and slugs had a slime on the surface of the body which was on the alkaline side of the scale. That was the typical soil of the creature. When they came in contact with chemicals which differed to a considerable degree from the condition of the slime they were anesthetized. But when the difference was a little greater they were killed. A tiny particle of copper sulphate, ferrous sulphate or aluminium sulphate brought about an electric reaction with the slime of a seven inch slug, which resulted in its going into convulsions and dying quickly. They were perfectly mummified, of brown color when the reaction was

complete. The other day I saw a mummy in the American Museum of Natural History of a man who perished in a Peruvian mine and he was covered with copper salts, and I thought that perhaps a mummification similar to that taking place in the snail had resulted.

All that was necessary to obtain quick control was to sprinkle small crystals of ferrous sulphate and copper sulphate on the ground around the yard and especially around the plants to be saved. The next day there were many dead snails and slugs at these chemical barriers.

The choice for the practical work fell upon ferrous sulphate, because its price was less than four cents a pound wholesale; it killed the snails and slugs quickly; it acted as a plant food and stimulant; it would assist in the control of soil nematodes; if the dogs or cats ate it or licked it the result would be beneficial if they had intestinal worms. Every requirement was fulfilled.

Another example comes from my practise in the Island of Negros in the Philippines. The dominant soil pest of sugar cane was the white grub. They were only present on soils that had an acid reaction and it was found that the pH of the grubs was usually a little more acid than that of the soil. The proper direction of treatment was to bring the soil condition toward that most suitable for sugar-cane, which is pH 7. For those species present in Negros the writer did not find any in soils above 6.8. So all that was necessary was a heavy dressing of lime.

Many fields of sugar-cane were very yellow. The soil analysis showed that the potash ratio while within the supposed safety-limit was on the verge of deficiency. Nematodes were very bad at the roots, as was the Pythium rootrot. The simple treatment of 250 kilograms of potassium sulphate per hectare remedied the situation and the cane became green and grew rapidly while that untreated did not grow any more. A heavy treatment with lime accomplished the same result although slower in initial action.

These examples are merely given to emphasize some of the points given above.

HABITS OF SOUTH AMERICAN EQUATORIAL BUTTERFLIES

BY CHARLES LOUIS POLLARD

In the rather extensive literature of South American Lepidoptera, there is little discussion of the idiosyncracies of various species of butterflies, such as their postures, methods of flight, actions when pursued, and preferred habitats. It is the copious treatment of this phase of the subject which lends so much interest to the works of W. H. Edwards, Scudder and other writers on North American butterflies. Various monographers in Seitz's "Macrolepidoptera" comment on the habits of certain insects, but many of the statements are evidently based on casual observations within a limited area.

The impressions presented in this paper have been gained from field work in the vicinity of Para, Brazil, Iquitos, Peru, and various localities in British Guiana. I have received much information from Rev. A. Miles Moss, who for nearly twenty years has collected and studied the Lepidoptera of Para, and who has made several valuable contributions to "Novitates Zoologicæ"; also from Miss Margaret E. Fountaine, an English entomologist who has devoted many years to the breeding of butterflies in nearly all parts of the world. To both of these I wish to tender appreciative thanks.

A collector visiting the tropics for the first time will notice at once a number of differences between the insects he encounters and those with which he is familiar at home. He will first of all be impressed with the abundance of species as contrasted with the paucity of individuals. This phase of tropical butterfly life was fully discussed by Bates and Wallace, and has been emphasized by many later authors. Chief among the various factors which have combined to originate a large number of species is the wealth of tropical vegetation, which at the equator includes a variety of food plants distributed over so vast an area that the individuals of a given form must perforce have a wide range. One does not observe well marked plant societies comparable to

our alder swamps, pine groves, birch woodlands or scrub oak barrens, each supporting a distinct insect fauna. On the other hand an acre of jungle may include fifty or more trees and shrubs and innumerable epiphytes and herbaceous plants. As a natural result of this condition, the butterflies of unrelated families have often adopted similar habits, a tendency increased by the number of enemies with which they have to contend in all stages of their existence.

Climatic factors also affect the habits to a marked degree. The strictly sun-loving species are fewer than in temperate regions, and at midday only the swift Catopsilias, some skippers, and the common Anartias are to be seen on the wing in open fields or clearings. Other butterflies must be sought in or near the forest, where they are less subject to the attacks of lizards, and where they may be protected from torrential downpours of rain. It is therefore evident that the collector cannot as a rule go forth in the expectation of finding a desired insect in any particular habitat. This seems strange to any one who has hunted butterflies in our northeastern states and knows that he must look for certain forms in meadows and pastures while others must be sought along a tree-bordered road. Many of our temperate species are distinctly local in habitat, being confined to the locality in which their food plants occur, as for example *Epidemia epixanthe* in cranberry bogs, or *Euphydryas phæton* in swampy meadows containing the turtlehead (*Chelone glabra*). But one may stroll along an equatorial jungle path and encounter within a short distance representatives of almost every family.

Narrow trails through the forest usually afford the best collecting in the tropics, as the insects appear to be suspicious of a broad road, especially where the shrubbery has been cut away. This is probably because lizards abound in clearings, and judging from the many individuals I have seen with symmetrical bites taken out of the hind wings, it may be inferred that these, together with certain insectivorous birds, are the principal enemies of the imago. This assumption is strengthened by the fact that very few butterflies except Prepona, Ageronia and Gynæcia habitually alight on tree trunks, and practically none

on the ground except along water courses in the dry season. The favorite perch is on a leaf at the tip of a branch, most erycinids and some hesperids preferring the under side. The Ageronias sit on a tree trunk head downward with expanded wings, the upper surface of which is always protectively colored; the Preponas, on the other hand, repose with erect wings, concealing the brilliant blue patches of the upper surface. The geotropic pose is doubtless to guard against an enemy crawling up the trunk, but even the active Prepona does not always escape the agile lizard.

Large spiders having their lairs within coiled leaves, and others lurking among flower clusters, prey upon butterflies, while predacious ants, dragon flies and robber flies are everywhere abundant. It is not surprising, therefore, that tropical butterflies, even among the protected groups, are far more timid than those of temperate regions, dashing away at the first movement of the net. They are adepts in the art of dodging, and nearly all species have developed an erratic flight. This is especially true of the Satyridæ and the clearwinged ithomiids, which zigzag close to the ground in the depths of the forest, alighting frequently but instantly arising. Lycaenids and erycinids weave in and out of the bushes with so swift and irregular a flight that it is difficult for the eye to follow them; and some members of the latter family have the curious habit of landing on the upper surface of a leaf and immediately running around beneath it. Some skippers imitate the erycinids in habit, while others dart to and fro in the forest after the manner of dragon flies, often returning to the same perch. The only groups that consistently exhibit a straight and rather slow flight are the Heliconiidæ and Papilios of the Aristolochia group, both of which are protected by their odor from most of their natural enemies. When disturbed, however, the heliconids fly aloft among the trees, while the papilios dive into the forest where no net can reach them.

This similarity of flight among unrelated families is very characteristic of the tropics. Until its capture one is never certain whether a small butterfly is a Thecla, an erycinid, a hesperid or a nymphalid. The day flying moth Urania is practically undistinguishable from a Papilio; and certain Satyridæ dart about like lycaenids.

The Morphos have a graceful, undulating flight, coursing up and down the forest lanes or along tree bordered creeks. They are always attracted by anything of their own color, as a blue ribbon or even a blue dress; but it requires a deft pass and a supple wrist to secure one on the wing. Like their crepuscular relatives, the Caligos, they are readily attracted to a bait of fruit soaked in beer or rum, and sometimes become so sluggish from over-indulgence that they may be picked off with the fingers. A number of nymphalids may also be taken at bait, but they are as a rule much more wary.

A remarkable case of protective coloration enhanced by instinctive habit came to my attention at Wismar, in British Guiana. I noticed occasional flashes of brilliant blue among the shrubs bordering a clearing, too small to be produced by any Morpho. On capturing the insect I found it to be one of the larger species of Thecla,* having wings of an intense sapphire blue above, the under surface being ashen gray, marbled with brown. Similar contrasts between the two surfaces are, of course, common in members of this genus. But the butterfly in question has adopted the habit of taking wing with a quick dart and almost immediately alighting, when its closed wings render it practically invisible. This maneuver is repeated as often as it is disturbed so that the conspicuous coloration is exhibited to the smallest possible extent.

This is but one of the many remarkable protective adaptations which are to be observed everywhere among tropical insects, the study of which adds zest to collecting, and repays the student for all the discomforts and vicissitudes of the chase.

* *Thecla damo.*

ANAPHOIDEA CALENDRÆ GAHAN, A MYMARID PARASITE OF EGGS OF WEEVILS OF THE GENUS CALENDRA[1]

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ABSTRACT

The corn billbug egg parasite, *Anaphoidea calendræ,* is a monembryonic, gregarious, hymenopterous insect of the family Mymaridæ, parasitizing eggs of several species of *Calendra,* especially *C. minima, C. parvula* and *C. callosa,* all of which hosts are very destructive to corn, small grains and grasses. A usual number of parasites developing in one host-egg is seven—one male and six females. The species is able to perpetuate itself in the eggs of numerous additional species of beetles of this genus, and occasionally it matures three times the usual number, especially when parasitizing the eggs of the larger species. Its known distribution is such as to indicate that it is established throughout the eastern half of the United States. It has been found to destroy seventy-five per cent. of the billbug eggs in *Agrostis alba,* in which host plant of *Calendra* it has been most intensively studied. In the latitude of St. Louis, Mo., there are

[1] Gahan, A. B., 1927. Miscellaneous Descriptions of New Parasitic Hymenoptera with some Synonymical Notes. Proc. U. S. Nat. Mus., Vol. 71, Art. 4, pp. 1–39 (31–35).

[2] The writer wishes to acknowledge valuable inspiration in the study of this mymarid from Dr. L. O. Howard and Charles C. Hill; indebtedness to Mr. A. B. Gahan, who described this species and generously lauded the work; and indispensable assistance from the laboratory staff, R. C. Lange and Hervey E. Roberts, in securing the necessary *Calendra* eggs. Especial appreciation is due Miss Frances H. Pickel for watching and aiding in recording the behavior of these tiny adults, and to Alexander F. Bucholtz for the dissections in the study of living eggs and young larvæ. Particular thanks are due to Professor R. W. Harned, A. and M. College, Miss., through whose generous cooperation with the Bureau of Entomology the first authentic ***Anaphoidea calendræ*** were taken.

at least four generations annually, sometimes probably seven generations. The larvæ remain inactive from July, August, or September, pupating in the following spring.

INTRODUCTION

Anaphoidea calendræ, the only recognized internal insect parasite in the eggs of species of *Calendra* (*Curculionidæ*), was established as a new species by Mr. A. B. Gahan, from material collected by the writer in Mississippi and Missouri in 1922 and subsequently.[3] It has responded well, under laboratory conditions, to breeding through numerous species of the host genus and has attracted the attention of the Hawaiian Sugar Planters' Association as a possibly adaptable parasite for introduction into Hawaii for the control of the sugarcane borer, *Rhabdocnemis obscurus*. This paper summarizes the work done on this species, except that done for the Hawaiian Sugar Planters' Association by Dr. F. X. Williams.

GEOGRAPHICAL DISTRIBUTION

The first positive record of distribution of this interesting parasite was obtained by rearing it from a *Calendra* egg collected at Greenville, Washington County, Miss., June 15, 1922, and from two eggs collected at Grenada, Grenada County, Miss., the following day, all of which issued at the laboratory on June 23.

The next locality yielding this parasite was Boschertown, St. Charles County, Mo., issuing July 10, 1922.

Some Calendra eggs gathered from the laboratory plats at Webster Groves, St. Louis County, Mo., for parasitization by the *Anaphoidea calendræ*, yielded parasites, some on July 10, 1922, the day of the collection.

Other localities from which this parasite has been collected are Grover and Kirkwood, St. Louis County, and Rocheport, Boone

[3] The writer narrowly missed discovering this species in 1915, when he observed two eggs to be developing spots and therefore discarded them as spoiling. Two tiny hymenopterous insects were also recovered from a cage in which eight eggs had been placed on July 15, 1915, from timothy at West Lafayette, Ind.

County, Mo., Elberon, Monmouth County, N. J., and, beyond a reasonable doubt, West Lafayette, Tippecanoe County, Ind.

THE HOST-PLANTS AND EGGS OF CALENDRA

Parasitized eggs of the several species of the genus *Calendra* are obviously not determinable by rearing. Furthermore, approximate determinations only can be made by correlating the host-plant, the host-egg, and the locality, aided imperfectly by measurements of the egg.

The host-plant of Calendra at Greenville, Miss., was *Juncus torreyi*. Eggs from this plant collection yielded one adult *Calendra callosa* and one adult *C. destructor*.

The Calendra host-plant at Grenada, Miss., was *Juncus acuminatus*, which contained, in one of the two collections yielding the parasite, one egg which proved to be *C. destructor*.

The plant at Grover, Mo., in each collection, was *Agrostis alba*. In a large series of Calendra eggs collected July 17, 1925, sixteen proved by rearings to be those of *C. minima*, and two, of *C. parvula*.

The plants at Kirkwood, Mo., were timothy and *A. alba*, chiefly the latter. *Calendra parvula* and *C. minima* infest each plant. *C. parvula* is dominant in timothy, *C. minima* in *A. alba*.

The plant at Rocheport, Mo., was *Cyperus esculentus*, which yielded Calendra eggs from which *C. callosa* was reared.

The plant at Boschertown, Mo., was terrell-grass, *Elymus virginicus*, which yielded a Calendra egg which proved to be that of *C. minima*, apparently the only species of the genus Calendra breeding in it.

The plants at Webster Groves, Mo., were timothy, *A. alba*, and *C. esculentus*, and it is inferred that the hosts of the parasites in this locality are *C. parvula*, *C. minima*, and *C. callosa*.

The Calendra host-plant at Elberon, N. J., was timothy and the host-egg probably that of *C. parvula*.

As *Anaphoidea calendræ* parasitizes one or more of these three very common species of the genus Calendra in Mississippi, Missouri, and New Jersey, it may be expected to occur generally where these hosts occur, from South Dakota to Texas and east to the Atlantic Coast.

ECONOMIC IMPORTANCE OF ANAPHOIDEA CALENDRÆ

Of the seventy-five or more known species of the genus Calendra occurring in the United States, all are potential destroyers of corn and small grains and grasses, all of them in the adult stage and many in the larval stage. Damage by them to lawns, golf courses, and pastures is particularly difficult to appraise. It seems fairly certain from my observations, that every sod that is two years old or older is substantially infested. Damage to timothy may be easily demonstrated by lifting bunches of this grass while the ground is dry in summer and observing the percentage of the corms that have been excavated or that have the bases of the corms and the roots completely severed from the stalk. The failure of the timothy to be profitable for harvest in its second or third year may be attributed largely to the work of species of this genus. The manner of growth and size of stems of bluegrass, Bermuda grass, and the bent grasses, all of which are subject to heavy infestation, make it much more difficult to perceive in them than in timothy the havoc wrought by these weevils.

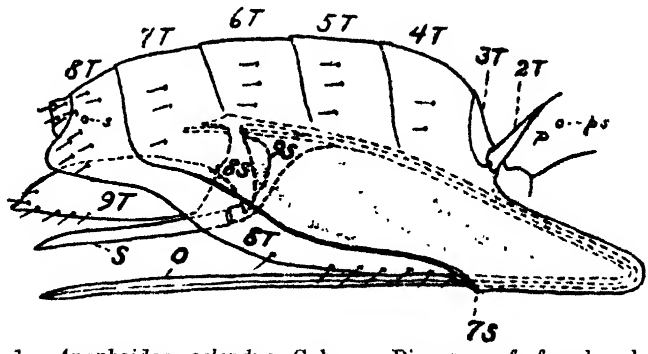

FIG. 1.—*Anaphoidea calendræ* Gahan. Diagram of female abdomen. P, propodeum; ps, Propodeal spiracle; 2T, Second tergite; 3T, Third tergite; 4T, Fourth tergite; 5T, Fifth tergite; 6T, Sixth tergite; 7T, Seventh tergite: 8T, Eighth tergite; 9T, Nine tergite; O, Ovipositor; s, spiracle; S, Ovipositor sheath; 7S, Seventh sternite; 8S, Eighth sternite; 9S, Ninth sternite. (After Gahan, A. B., Bureau of Entomology, U. S. Dept. of Agriculture. Proc. of the U. S. N. M. Vol. 71, Art. 4, p. 32.)

The economic importance of *Anaphoidea calendræ* as a control of these destructive corn billbugs is best expressed in ob-

served percentages of infestation found in field examinations. Occasional small collections of one to five eggs each were 100 per cent. infested. Extensive collections were made at two places, one near the field station in Webster Groves, the other about twenty-five miles west, near Grover, Mo. At the latter place one collection of twenty-one eggs, June 22, yielded one parasitized egg, 4.8 per cent., while a second colection of ninety-eight eggs, July 17, yielded thirty parasitized eggs, 30.6 per cent. The evident difference is attributable to the stepping-up of efficiency as the broods progress. At Webster Groves a succession of collections was made for seven days, beginning July 8, ending July 16. One hundred and twelve eggs were collected, yielding eighty-five parasitized eggs, 75.4 per cent.

This parasite attacks the host egg and destroys it at the point of oviposition.

The larvæ are gregarious, usually about seven, in the ratio of one male to six females, in each egg.

The life cycle is short, usually complete in fourteen to seventeen days in warm weather.

The breeding season is long, admitting, apparently, of seven broods a year, in the St. Louis latitude.

The parasite is known to attack three very common, seriously destructive species of billbugs and, in control, adapts itself readily to numerous other species.

It is widely distributed, being known to occur in the Gulf region, on the Atlantic Seaboard and in the central Mississippi River Basin.

HAWAIIAN INTEREST IN ANAPHOIDEA CALENDRÆ

Mr. C. E. Pemberton, on behalf of the Hawaiian Sugar Planters' Association, Honolulu, T. H., began correspondence with the writer, July 11, 1927, after reading Mr. Gahan's notes following his description of the new species. He stated that the sugarcane borer, (*Sphenophorus*) *Rhabdocnemis obscurus,* has been a major problem in their cane fields, in Hawaii, for over forty years and still does considerable damage in spite of one successful introduction of a parasite by Mr. Muir in 1910.

Mr. Pemberton spent two and a half years in the Philippines, Java, Borneo, Celebes, and other islands of the Malay Archipelago in search of natural enemies of this weevil. Though he found and shipped seven or eight predatory or parasitic insects, and collected quantities of eggs of *Rhabdocnemis, Calendra, Diocalandra, Sphenophorus,* and *Rhynchophorus,* and Mr. Muir had made collections in New Guinea, Java, Amboina, and other places between 1906 and 1910, neither investigator had found an egg parasite of any beetle belonging to these genera. The records of *A. calendræ* were therefore of particular interest.

Mr. Pemberton stated that *Rhabdocnemis* imbeds its eggs in the sugarcane stalk, and inquired into the oviposition habits of Calendra, also concerning the sizes of eggs, seasons of activity, the possibility of accumulating a supply of parasitized eggs and of shipping them.

The outcome of this and further correspondence was that the Hawaiian Sugar Planters' Association decided that there was enough chance of a profitable introduction of this mymarid egg parasite into the sugar plantations of Hawaii, to make the attempt in 1928. The work was entrusted to Dr. Francis X. Williams, of the Sugar Planters' Experiment Station Staff, who arrived at the Webster Groves laboratory May 10, and with the cooperation of the Bureau of Entomology at this laboratory, assembled a mass of material and carried this to Hawaii in person, without issuance en route. Dr. Williams left the laboratory July 21, which was one generation earlier than the hibernating generation.

He reported that emergence was satisfactorily accomplished, but evidence of the parasites attacking eggs of *Rhabdocnemis obscurus* was lacking.

Rearings from Eggs Parasitized in Nature and in Control

The number of adults maturing from Calendra eggs parasitized before they were collected and parasitized under control are given in the accompanying table (Table 1), first the number of males, then females, then the number of sexually undetermined under an interrogation mark, with an asterisk where not all of the matured adults issued.

As the *C. ? minima* collection of eggs is the outstanding series of supposedly one species, it will be well to study first the numbers per host egg and ratios of sexes in this species. One egg produced 3 adults; 2 produced 4; 6 produced 5; 21 produced 6; 34 produced 7; 10 produced 8; 4 produced 9; 1, 10; 2, 11; and 1, 12. Seven adults per host egg is much more frequent than any other number, six per host egg is next. Possibly the higher numbers may indicate that some eggs in the series are those of a larger species, *C. parvula*, for instance.

In the matter of sex ratios, 12 were without a male, 58 had one male each, 8 had 2 each, 3 had 3 each, and 1 had 6 males and no females, the only host egg in 82 from nature maturing males only. Normally, both sexes are present. However, four parasite groups out of six groups brought to maturity from one of the first three groups used for propagation yielded males only, as if the species were arrhenotokous and not all the females in the parent group had mated. Subsequently, no eggs were submitted for parasitism until matings were observed.

Only one *C. minima* egg of known parent was parasitized. The number of *A. calendra* developing in it was seven, the number which occurred with greatest frequency in the large series of supposed *minima*.

The records of parasitism of eggs of species of Calendra larger than *C. minima* indicate that the sex ratios in all species are essentially as in *C. minima*, and that more than the normal lot of eggs are deposited in some large host-eggs.

It is conceivable that such irregularity may occur alike in the several host-egg species, but that only in the host-eggs of larger content will the increased number of progeny reach maturity, while those in host eggs of lesser capacity will perish by starvation, or the number reaching maturity may be reduced by cannibalism.

Occasionally parasitism took place with results fatal both to the host and to the parasites.

NUMBER OF GENERATIONS

It may be expected that the number of generations annually is variable in each locality, partly owing to a normal overlapping

TABLE I

RECORDS OF NUMBERS OF THE RESPECTIVE SEXES MATURING FROM *Calendra* EGGS OF GIVEN SPECIES. (THE COLUMN UNDER THE QUESTION MARK REPRESENTS ADULTS COUNTED BUT LOST WITHOUT SEX BEING RECORDED. THE ASTERISK MARKS THE GROUPS IN WHICH NOT ALL ADULTS ISSUED FROM THE HOST-EGG.)

Host spp.	Number of parasites ♂	♀	?	No. eggs	Number of parasites ♂	♀	?	No. eggs	Number of parasites ♂	♀	?	No. eggs
C. ?minima	0	3*		1	0	5		1	0	5*		1
	0	5	1	1	0	6		2	0	6*		1
	0	6	1	1	0	7		2	1	3		2
	1	4		1	1	5		10	1	5*		4
	1	6		23	1	6*		5	1	7		5
	1	7*		4	1	8		1	1	9		1
	1	4	2	1	1	6	1	1	2	4		1
	2	4*		1	2	5		1	2	7*		3
	2	9		1	2	10		1	3	2		1
	3	3	1	1	3	7		1	6	0		1
C. minima	1	5	1	1								
C. ?callosa	1	5	2	1	1	1	1	1			7	1
	7		1	1								
C. callosa	1	2		1	1	5		1	1	7		1
	1	9		1	1	10		1	8	0		1[1]
	9	0		1[1]	10	0		1[1]	22	1		1[1]

[1] These four eggs were parasitized by a single group of adults.

TABLE I (*Continued*)

Host. spp.	Number of parasites ♂	♀	?	No. eggs	Number of parasites ♂	♀	?	No. eggs	Number of parasites ♂	♀	?	No. eggs
C. ?destructor		1	10	1			9	1			13	1
	1	8		1								
C. destructor	0	1*		1	0	12	4	1	1	6		1
	1	7		1	3	6		1	5	2		1
	8	0		1	13	1		1				
C. ?parvula	0	5	1	1	1	1		1	1	5		1
	6	2		1								
C. parvula			10	1			13	1	1	9		1
	2	8		1								
C. ?pertinax			10	1								
C. pertinax	0	8		1	1	4		1	1	5		1
	1	6		1	1	7		1	2	19		1
C. costipennis		9	4	1	1	10		1	1	11		1
	1	12		1								
C. maidis	0	9		1	1	7		1				

of broods, partly to a variation in speed of development in the several hosts, partly to temperature fluctuations and partly to latitude.

Eggs of the several species of Calendra believed to be hosts of *Anaphoidea calendræ* in the Webster Groves, Mo., locality have been taken occasionally as early as May 1, and as late as September 3.

The records of eight series of rearings of *A. calendræ* including the issuance of thirty-five groups, are given on the accompanying chart (Fig. 2). The dates of collection are represented by the left termini of the solid lines. The dotted extensions of these lines indicate the unknown beginnings for the respective series. All records are from Missouri, in the latitude of St. Louis. The date of issuance of each group of adults is indicated by a colon to the right of the host-species name.

Those lines projected to the right without a terminating colon represent groups whose larvæ continued into winter.

The dates are shown at top and bottom of the chart, and all groups issuing in one day are in a vertical line.

No series was continued through the complete year. Three of the series observed show conclusively that there may be at least four generations annually. Each series starts with an egg deposited during the then current season and completes two more generations during the year.

The first entry made is that of a group of *Anaphoidea calendræ* within a *Calendra ? minima* egg collected June 5; the egg had been deposited shortly before, and hence this was not a group of hibernating parasites. This group may therefore represent the eggs of the first or of the second brood of parasites, and might very doubtfully be of the third brood. In case it belonged to the first brood, we may assume that the hibernating brood of parasites issues in this region about June 3, the first brood about June 19, the second brood about July 3, the third about July 16, the fourth about July 30, the fifth about August 15, the sixth about September 1, and that suspension of development of larvæ occurs in an indeterminate fraction of the host-egg groups in the fourth, fifth, sixth, and seventh broods, but chiefly in the sixth.

It is not to be expected that all groups of adults from the hibernating brood would issue simultaneously. Probably the

bulk of them would issue in any given locality within a period of ten days. Each group should live in the adult state for three or more days, and oviposit throughout that time. In the duration of the life cycle of individual groups there is a variation of from 13 to 18 days (38 per cent.) in *destructor* as host, 14 to 18 days (28 per cent.) in *parvula,* and 14 to 26 days (85 per cent.) in *costipennis.* It thus becomes apparent that no vertical column in this chart can be considered narrowly to define any one brood.

According to records made by the writer, the summer broods of *A. calendræ* developed as follows: In eggs of *C. parvula,* two eggs, 14 and 18 days, an average of 16 days; in eggs of *C. minima,* one egg, 18 days; in eggs of *C. costipennis,* three eggs, 14, 17, and 26 days, an average of 19 days; in eggs of *C. pertinax,* five eggs, 14 to 17 days, average 15 days; in eggs of *C. maidis,* two eggs, 17 and 18 days, average, 17.5 days; in eggs of *C. destructor,* seven eggs, 13 to 18 days, average, 15.2 days. These twenty-nine groups required an average of 16.6 days between the issuance of the parent adults and the progeny adults. Development in eggs of *destructor* occurred more quickly than in those of *callosa,* as shown by groups of common parentage and date. Opportunity for observation of development in other species was not so favorable by reason of the smaller numbers under investigation.

BEHAVIOR OF ADULTS

The behavior of the adult *Anaphoidea calendræ* is quite varied, often ludicrous.

When ready to issue from the host egg, they bite out pieces of the amnion and chorion till they have made one or more approximately circular exits. As the adults issue, they run swiftly and erratically or deliberately preen their antennæ, wings, and feet. They are proficient at jumping. Often they feigned death, as the result of collision with another adult or with the walls of the cage. After feigning death, they would rise to their feet and proceed as if nothing had happened. Occasionally they were observed to fly within the cage. When one escaped to the desk top and took flight, it was visible when the light hit its wings favorably. The flight was jerky, more or less spiral, and van-

REARINGS OF A. CALENDRÆ, SHOWING DATES, DURATION, SEQUENCE AND HOSTS

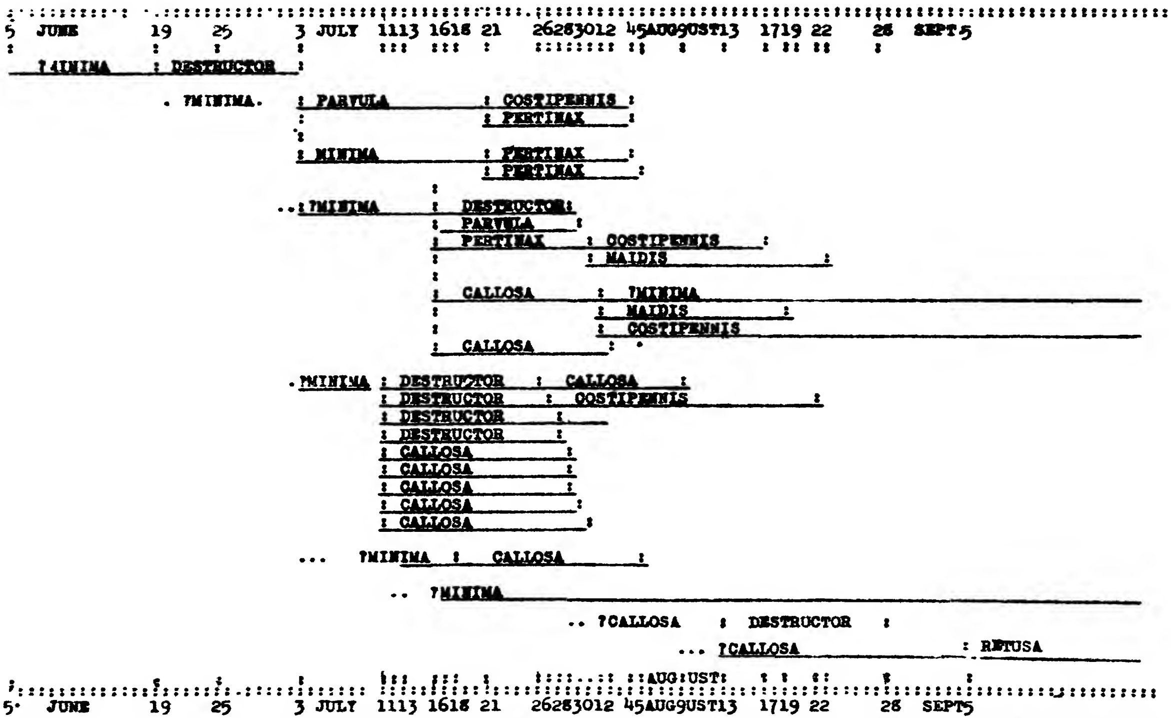

Figure 2. Records of twenty-eight groups of *Anaphoidea calendræ* of known duration, arranged on vertical date lines to indicate broods per year. All are of the latitude of St. Louis, Mo. The first entry of each rearing was a group subsequent to the issuance of the hibernating group.

ishing. Most flights were very short, so that the attendant watched for it to alight within three or four inches from the starting point, prepared to place an inverted culture tube over it for its recapture.

Heliotropism among the adults is sufficiently pronounced to aid substantially in handling them, as discussed under "Methods."

There appears to be no definite rule for priority of issuance of the sexes. Very promptly after issuance, the male seeks to find and mate with a female. Mating takes place with the male facing the reverse direction from the female, and with their ventral surfaces together. The apex of the abdomen of the male is applied to the base of the ovipositor of the female at the suture of the seventh sternite and nearly vertically below the caudal end of the propodeum. The contact may be almost instantaneous or may take several seconds. On one occasion the male was observed to tap the apex of the abdomen of the female while mating. The female extended her ovipositor as completely as if ovipositing. One female held the apex of her body up at an unusual angle for several seconds after mating. Frequently females stopped running at the touch of the antenna of a male.

Females evinced varying degrees of interest in eggs exposed to them. Efforts were made to supply the eggs in the condition most acceptable. It was anticipated that strictly fresh eggs would be most acceptable, and special care was taken to maintain this practice. However, the first egg attacked under observation contained a Calendra larva sufficiently developed to show it in motion. Often several eggs were exposed simultaneously. Sometimes as many as three females would pounce upon one egg and proceed to oviposit, ignoring the other eggs throughout the period of exposure. It was thought there might be some odor or substance left by the Calendra female upon or about the egg at time of oviposition, which determined the attractiveness of the egg to the parasite. Eggs exposed to the parasites in the egg cell in a small piece of the plant surely had the maximum possible odor from the female but were not attractive in any test made.

The adult female parasites were very demonstrative of their interest in Calendra eggs. There was the occasional business-like stab as quickly as the adult could attack the egg, sometimes all done in a few seconds. Frequently the successful stab was made only after much antennal tapping of the egg and much probing with the ovipositor in search for some portion of the chorion through which the ovipositor might be plunged. The adults often stand on tip-toe and try to apply the tip of the ovipositor vertically and at various other angles, sometimes using the tip of the abdomen to help improve the application of the ovipositor. When the thrust is successfully made, it may be deep, the body fairly close to the egg, or shallow, the ovipositor exposed equally with the legs, so that it was difficult to tell whether just six legs or six legs and the ovipositor were touching the egg. The inserted ovipositor may be held motionless or may be given various depths with one insertion, and may be given a shift in slant. The withdrawal of the ovipositor may be made with such ease that the observer cannot tell directly that there was a withdrawal. Sometimes the withdrawal is with apparent effort.

Other demonstrations of interest in the egg are contacts of the ventral surface of the abdomen on the egg, as if caressing the egg, walking on the egg and dropping the body almost, but not quite, to the egg, and contact of the mouth parts with the chorion, as if lapping up moisture or other substance from the surface of the egg. This behavior was at no time observed at a point of oviposition, as if utilizing an exudation of egg content.

THE EGG[4]

Several Calendra eggs, especially those of *C. maidis*, were attacked under observation by adult *Anaphoidea calendræ* and oviposition apparently was successfully accomplished. A few of these eggs were dissected immediately in distilled water, with stains, to make observations and avoid the distortion likely to

[4] Dissection studies of the egg and of the larva were made by Alexander F. Bucholtz, Field Assistant, Cereal and Forage Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture, in the summer of 1928.

occur in the usual killing, fixing, infiltrating, and staining operations.

Acid fuchsin, eosin, methylin blue, and Langeron's cotton blue were tried, the last named giving the best results. It is a fixative stain. Its formula is: Acid phenol, 20 grams; acid lactic, 20 grams; glycerine, 40 grams; distilled water, 20 grams; cotton blue, a few grains on point of knife.

The first eggs thus dissected revealed nothing. Eggs were then dissected out from ovaries of recently issued *A. calendræ* adults. These have the caudal third scarcely half as thick as the cephalic two-thirds, the cephalic end tapering for about one-fifth of the total length. *A. calendræ* eggs were dissected from ovaries of several adults and from three host-eggs, with measurements as follows:

From a female 0.77 mm. long, reared through *C. minima* egg, one egg, 0.175 mm.; three, 0.192 mm. each; two, 0.227 mm. each; one, 0.262 mm. long.

From an unmeasured female, through *C. minima* egg, three eggs, 0.332 mm. long.

From a female 0.962 mm. long, through *C. maidis* egg from progeny from *C. minima* egg, one egg, 0.244 mm. long.

From a female 1.015 mm. long, through *C. maidis* egg from progeny from *C. minima* egg, one egg, 0.262 mm.; two, 0.280 mm. each; one, 0.297 mm.; one, 0.315 mm. long.

From a female 1.032 mm. long, through *C. maidis* egg from progeny from *C. minima* egg, one egg, 0.210 mm.; one, 0.227 mm.; two, 0.244 mm. long.

From a *C. maidis* host-egg, eight eggs, averaging 0.140 mm.

From a *C. maidis* host-egg, one egg, estimated 0.165 mm. long.

From a *C. maidis* host-egg, one egg 0.194 mm. long, oviposited by a female reared through *C. minima* egg.

A. calendræ eggs dissected out from the ovary and yet alive have a turgid appearance and the fine granular content reaches up to the egg-wall. The granular cytoplasm appears denser in the middle than elsewhere. This form is not definitely maintained in the earliest form observed in the host. Also, the size of the egg is reduced.

LARVÆ AS SEEN BY DISSECTION

Within the host eggs, *A. calendræ* were observed to continue as eggs for 40 to 60 minutes after oviposition. Larvæ of the first instar were found 5 hours and 45 minutes after oviposition, at which time eight larvæ were removed from one *C. maidis* egg.

The first larval instar is represented by a long oval body, broadest about one-fourth or one-third of the body length back of the cephalic end, with a narrowed, tapering, appendiculate portion at caudal end. The alimentary tract appears definitely to terminate at base of this caudal portion. In this form, the larva bears at least four large setæ, about as long as the thickness of the body. These setæ do not stain. Measurements in the first instar are: One, 0.244 mm. long, from *C. maidis* egg, 28 hours after oviposition; one, 0.245 mm. in total length, the body proper being 0.175 mm., and the caudal appendage, 0.070 mm.

The second larval instar from 52 to 55 hours after oviposition. At this stage the larva has lost the caudal appendage and the setæ. A development at the cephalic end suggests mandibles slightly in anterior contour, but without significant adaptability to function. Measurements in the second instar, 52 to 55 hours after oviposition, from one *C. maidis* egg, are: One, 0.385 mm. long, 0.192 mm. wide; one, 0.385 mm. long, 0.157 mm. wide; one, 0.420 mm. long, 0.175 mm. wide; one, 0.367 mm. long, 0.157 mm. wide; and one, 0.350 mm. long, 0.175 mm. wide.

The third larval instar was studied from a series of larvæ removed from an egg of *C. venatus*, 100 to 103 hours after oviposition. They were nearly all short oval in form, being as thick as wide. They absorbed cotton blue stain very rapidly, obscuring anatomic characters. Measurements recorded for five are: 0.618 mm. long and 0.490 mm. wide; 0.635 mm. long, 0.367 mm. wide; 0.542 mm. long, 0.315 mm. wide; 0.517 mm. long, 0.437 mm. wide; and 0.507 mm. long, 0.350 mm. wide. One larva was in less compact form and distinctly revealed segmentation before staining, but the actual number of segments was not determined.

Hibernating larvæ dissected out of an egg believed to be *C. minima* were of the same compact oval-globular form of several dissected out of the *C. venatus* egg. It is assumed that these were also in the third instar. No molting was observed and no

exuviæ were found. Hence the assumption that there are three instars is on the basis of the three types of larvæ observed.

Anaphoidea calendræ eggs and larvæ found in dissected host-eggs indicate that reproduction in this species is not by polyembryony, and that the number of eggs found corresponds with records of issuance of adults.

LARVÆ AND PUPÆ AS SEEN WITHOUT DISSECTION

The accompanying table of host-eggs and observations of development of *Anaphoidea calendræ* therein (table 2), is arranged arbitrarily in the order of lapse of time between possible parasitization and first recognition of the parasite larvæ, without any particular test having been made at short, regular intervals to discover the larvæ. The shortest time required in this series for development of larvæ, visible with no higher magnification than a pocket lens, was 64 hours, in *C. destructor* egg 24169. It is possible that, with care, larvæ would have been recognizable in all other eggs within this same period of time.

Pupæ were recognized almost at the moment of pupation in *destructor* egg 24169, 184 hours, 55 minutes after exposure of host-egg to parasites, and in *costipennis* egg 24168, 406 hours, 28 minutes after exposure. Larvæ were definitely recognized in these two eggs 20 hours, 35 minutes, and 12 hours, 30 minutes, respectively, prior to the recognition of pupæ. Pupæ in another *costipennis* egg were recognized 257 hours, 41 minutes after exposure and, so far as observations of larvæ were recorded, might have been pupæ for 116 hours. The pupæ observed in the shortest time after exposure were in a *parvula* egg, 169 hours, 27 minutes from exposure.

Periods of time from exposure of host-eggs to *A. calendræ* adults to issuance of progeny adults ranged for the several species as follows: *C. destructor,* 307 hours, 40 minutes, to 379 hours, 4 minutes, 7 eggs; *costipennis,* 350 hours, 28 minutes, to 591 hours, 37 minutes, 2 eggs; *parvula,* 309 hours, 57 minutes, to 408 hours, 53 minutes, 2 eggs; *pertinax,* 303 hours, 30 minutes, to 408 hours, 6 eggs; ? *minima,* 336 hours, 40 minutes, 1 egg; *callosa,* 357 hours, 49 minutes, to 431 hours, 15 minutes, 6 eggs; *maidis,* 392 hours, 31 minutes, to 499 hours, 40 minutes, 2 eggs.

It is difficult to fix the causes for such variations in required time for development in different eggs of one species and of several species. Figure 1 visualizes the presence of variation for several groups on the same and on approximate dates, demonstrating that temperature is not entirely responsible. The host-species is not greatly the time controlling element. There appears to be no significant correlation between the number of individuals in the egg and the time of development.

The development of the parasites proceeds in this fashion, as seen with the aid of the hand lens: About 64 hours after oviposition, oval bodies, distinct as units from each other and from fat bodies, may be observed in the parasitized egg, even though the mandibles of the Calendra may be or may become prominent. As these oval larvæ grow, they take positions transverse or nearly so to the longitudinal axis of the egg, and surge back and forth in the spaces they have grown to occupy. No tendency was observed, in any normally filled egg, for them to change about.

When about to pupate, the larvæ change from transverse to longitudinal positions and the approach of pupation may thus be anticipated by several hours. As pupation takes place, the appendages become discernible before the heads or compound eyes. The compound eyes become discernible by their facets before any pigmentation has taken place. The color of the compound eyes progresses from white, through pale salmon, to salmon red, brilliant red, brown, and black. The bodies remain white from pupation until about 72 hours before issuance, and because of the brilliant red compound eyes they are strikingly beautiful at this pre-blackening moment. The black pigment first appears in the coxæ and ventral extensions of the eighth tergite, the armature for the ovipositor, then in pronotum and face, the general appearance of the egg passing through a slaty blue for a portion of a day before the pupa becomes black Unconsumed egg contents, when present, are white, contrasting strikingly with the black pupæ.

METHODS USED IN PROPAGATION

The adults of *Anaphoidea calendræ* are so small that special methods of handling them are necessary. A large sheet of

TABLE 2

SPECIES OF *Calendræ* EGGS, WITH NUMBER OF HOURS WITHIN WHICH THE SEVERAL GROUPS OF PARASITES WERE OBSERVED AS LARVÆ, AS PUPÆ, AND AS ADULTS, RESPECTIVELY, AND NUMBER (BY SEX) OF RESULTING ADULTS.

Species of host-egg	Time (hours) between exposure and first observation of—					
	Larva	Pupa	Adult,	♂	♀	?
destructor	64	185	352	1	7	
callosa	76	243	360	22	1	
callosa	78	245	386	9	0	
pertinax	80	193	359	2	19	
destructor	81	194	312	13	1	
pertinax	95	187	304	0	8	
pertinax	95		327	1	5	
callosa	97	320	432	1	5	
pertinax	98	191	309	1	7	
parvula	103	170	310	1	9	
costipennis	113	258	351	1	11	
callosa	118	285	400	10	0	
callosa	118	285	402	8	0	
destructor	122	287	308	3	6	1
destructor	122	287	380	6	2	
maidis	123	217	393	1	7	
pertinax	124	270	334	1	7	
destructor	124	222	335	1	6	
destructor	144	192	338	0	12	4
pertinax	144	239	408	0	0	5
costipennis	161	407	592	1	11	
destructor	169	214	330	8	0	
callosa	172	222	358	1	9	
maidis	211	379	500	0	10	
parvula	218	318	409	2	8	3
? minima		262	337	0	4	3

white paper is very desirable as a working background. Transparent containers of small size are indispensible. Opaque containers are impracticable, both as places in which the tiny creatures may be lost, alive or dead, and as receptacles from which they may escape with the admission of light or with the draft produced by the removal of lid or cork.

The type of container used in these studies was a culture tube about 35 mm. deep and 9 mm. in diameter, having a rounded bottom, and stopped with tightly bunched cotton. Each tube was marked with a number on a small bit of adhesive tape at rim, outside. The host-egg was placed in the tube before possibility of issuance of adults. After the adults issued, they were

watched in many instances until matings had taken place, certainly until it was known that both sexes were represented, when one or more Calendra eggs were placed in the tube by use of a delicate camel's-hair brush.

The adults are usually attracted to light fairly promptly. When necessary, the tube was darkened except at the bottom, to induce the adults to leave the mouth of the tube. Usually this was not necessary, as they would go toward the bottom when it was placed toward the source of light, either natural or artificial. While they were near the bottom, the stopper was removed, the egg or eggs were introduced, and the stopper replaced.

Several schemes were tried for supplying the eggs on a service tray composed of a longitudinal section of a plant stem, but this was too good a perch for the adults and removal was too often delayed by reason of the adults resting on it. Another difficulty was introduced when such device was placed in the tube. When the device contained moisture, this was deposited on the inside of the tube, thus reducing visibility and causing fatal adhesions of adults to the glass.

Further regulation of moisture within the tubes was attained by inserting bits of corn pith or dry or damp bits of white blotter, as conditions demanded. Atmospheric conditions within the tubes had to be regulated for the host-eggs as well as for the adult parasites.

Once under way, and with the earthen cages for host-eggs placed conveniently close to the parasite tubes, a new egg could be placed in the tube and the exposed egg removed by one opening of the tube, the brush and the stopper replaced, with a minimum chance for the escape of the adults. Even with the utmost care, sometimes the entire set of adults, more frequently a fraction of the set, would fly or jump out. Empty culture tubes may be placed vertically over one after another of the adults as expeditiously as possible, and when no more remain in sight, the captured adults may be returned to one tube, one at a time, by putting the mouths of the tubes together and holding the bottom of the one containing the greater number of adults to the

light until all are in one tube. These may be conveyed to the tube containing the host-egg, or the egg may more readily be transferred to the tube containing the adults.

The tubes containing parasites were laid on damp soil in closed tin salve boxes over night, with satisfactory results. Desiccation tendencies are generally forestalled, both in relation to parasites and to host-eggs, by this method of handling.

Eggs that had been exposed to adult parasites were kept in the Calendra egg cage, consisting of damp soil compactly pressed into the tin ointment box for about two-thirds the depth of the box, the eggs being given individual depressions representing definite sub-cage numbers, until the eggs hatched or showed parasite development.

Eggs revealing parasite development were given a new cage number, with records written from the standpoint of the parasite, and were kept on damp soil until the parasite pupæ began to blacken, when they were placed in the culture tubes with cotton stoppers, still on damp soil in tin ointment boxes. As the adults issued, the cycle of method was continued.

THE EXTERNAL MORPHOLOGY OF HYDROPHILUS OBTUSATUS SAY (COLEOPTERA: HYDROPHILIDAE)*

BY E. AVERY RICHMOND

I. INTRODUCTION

Hydrophilus obtusatus Say was selected for this study on account of its fairly large size, and because of its relative abundance and wide distribution which probably make it the most readily available species of the larger hydrophilids in this country. Moreover, there are several closely allied species belonging to the same genus, *Hydrophilus*, which could be substituted for *H. obtusatus* in case it were desirable to use such a beetle for class work. Although not as large as *Hydrous triangularis* Say or the rarer *Hydrous ovatus* G. & H., and so perhaps less desirable for study, the members of *Hydrophilus* seem to be more equally distributed over the world and have not been studied as extensively. The immature stages have been described by Bowditch, 1884; Wickham, 1895b; Richmond, 1920; and Wilson, 1923. A complete morphological study of a water beetle has never been made in the United States, and it is hoped that such a contribution may be of some value to the student as well as to the trained morphologist. It would be worth while if more extensive studies such as that of Korschelt, 1923, on *Dytiscus marginalis* L., were conducted in this country.

Several workers have figured *Hydrophilus* as one of a series illustrating the comparative anatomy of Coleoptera and other groups but no complete study of the external anatomy of *Hydrophilus* has been made. Forbes, 1922, and Stickney, 1923, have used both *Hydrous triangularis* and *Hydrophilus obtusatus* in their respective studies of the wings and head capsules of Coleoptera. *Hydrous triangularis* was used and figured by Newell, 1918, in her study of the male and female genitalia of Coleoptera; by Crampton, 1926, for his consideration of the

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neck and prothoracic sclerites of insects; and Tanner, 1927, in his paper on the female genitalia of Coleoptera.

Most European writers who have described the Hydrophilidæ have written concerning *Hydrous piceus* L., the largest and possibly the most common species of Europe, but the genus *Hydrophilus* has been somewhat neglected, except by d'Orchymont, 1911. Sharp and Muir, 1912, described the genital tubes of *Hydrous piceus* L., *Laccobius ytenensis* Sharp, *Berosus signaticollis* Sharp, *Berosus luridus* L., *Helophorus aquaticus* L., and *Dactylosternum subdepressum* Lap., in their paper on the comparative anatomy of the male genital tube in Coleoptera. In 1894, Escherich discussed the male genital system of Coleoptera and included *Hydrous piceus* L., Berlese, 1909, used drawings of *Hydrous piceus* L., and *Hydrobius fuscipes* L., in connection with a number of his morphological explanations. The most valuable piece of research on any one species was contributed by Balfour-Browne, 1911, as a result of his studies on *Hydrobius fuscipes* L., and many valuable ideas on the morphology of a hydrophilid were obtained from a study of his work. Brocher, 1912, carefully described the respiratory system of *Hydrous piceus* in great detail.

The specimens used for this present study were collected in swampy meadows adjacent to the campus pond of the Massachusetts Agricultural College at Amherst, Massachusetts. They were preserved in eighty per cent. ethyl alcohol until needed for study. In order to remove the soft tissues from the sclerotized portions of the beetle some of them were boiled in a ten per cent. solution of caustic potash. For examining the structures a Spencer binocular was used together with a Spencer high power Mazda microscope lamp (400 watts, 100 volts) for illumination. All of the measurements for the drawings were made by means of a cross-section, ocular micrometer, and the original drawings were sketched on cross-section paper, the squares of which were calibrated.

The drawings were then traced on bristol board and inked in, after being carefully checked over with other specimens besides the one drawn originally. As an explanation of the drawings it should be noted that the membranous areas have been closely

stippled whereas the lightly sclerotized regions have been only sparsely stippled. The interrupted or broken lines represent indefinite margins, indistinct areas, or underlying structures and the dotted lines have been used to indicate indistinct sutures, elevations, or depressions.

The investigations included in this paper were conducted entirely under the direction of Dr. G. C. Crampton, and I desire to thank him sincerely for his helpful advice and most considerate criticism. It was at the suggestion of Dr. H. T. Fernald that a morphological paper was included in my studies, and both he and Dr. C. P. Alexander have materially aided in my researches. For financial assistance I am greatly indebted to Mr. Edward M. Thompson of Brockton, Massachusetts, and to Mr. Otto Haas of the Rohm and Haas Company of Philadelphia, Pa.

II. History and General Description

The subfamily Hydrophilinæ, of which *Hydrophilus obtusatus* Say is a member, also includes the genera *Hydrous* Dahl, *Neohydrophilus* d'Orchymont, and *Tropisternus* Solier. *Dibolocelus* Bedel is now placed in the genus *Hydrous* as a subgenus. This subfamily is primarily distinguished from the other subfamilies of the Hydrophilidæ by the presence of an acute metasternal spine and its compressed meso- and metathoracic tarsi, which form oar-like appendages for swimming. The general color is usually reddish brown to pitchy black although some of its species occasionally possess yellow margins. The size varies from 9 mm. to 35 mm. in length.

The genus *Hydrophilus* was erected by De Geer in 1774, and *H. caraboides* L., was selected by Leach in 1815 as the type of the genus. The short, metasternal spine, never projecting as far as the caudal margin of the first ventral segment, and the acutely carinate prosternum, not grooved for the reception of the mesosternal carina, isolate this genus from the other members of the subfamily Hydrophilinæ.

The first specimen of this species to be recognized was collected by its author, Thomas Say, on one of his expeditions to the Rocky Mountains, and was described by him in 1823 as follows:

"Body oblong-oval, convex, black; head, a lunate indented line of confluent punctures befores the eyes on each side; orbits punctured; palpi and base of the antennæ, dark rufous; thorax with a very much abbreviated line of impressed punctures on each side before the middle, and a few lateral punctures; elytra very obtusely rounded behind; four series of punctures furnishing minute hairs, the outer one double; beneath sericeous, with minute yellowish hairs; pectus, prominence not bifid; sternum narrow and not canaliculate before, slightly emarginate near the anterior tip; posterior moiety a little flattened, with an impressed line; posterior tip rounded and hardly extending beyond the base of the postpectus; feet dark piceous. Length from 3/5 to 13/20 of an inch."

It is unfortunate that the original type has been destroyed and it would be quite advisable to select another individual or group of individuals to stand in its place.

Hydrocharis obtusatus has been included under *Hydrochara* Berth., 1827; *Hydrous* Brullé, 1835; *Hydrocharis* Hope, 1838; *Hydrœchus* Steph., 1838; and *Hydrochares* Solsky, 1876; but now seems to be properly placed in the genus *Hydrophilus*. It is very close to *H. caraboides* L. which is readily distinguished by the caudal, spine-like projection of its prothoracic keel. Zimmerman (see Le Conte, 1869) described a specimen, closely related to *Hydrophilus obtusatus* Say as *Hydrophilus grandis*, but Horn, 1876, considered it to be only a female of *H. obtusatus*. Only the elytra of Zimmerman's specimen now remain, so that it will be difficult to prove whether or not Horn's assumption was correct.

Knisch, 1924, lists *H. obtusatus* as a North American species and it does seem to be fairly well distributed over Canada and the United States. Literature and records at hand report its occurrence in Manitoba and Ontario, Canada; all of the New England states; New York, New Jersey, Pennsylvania, South Carolina, Florida, Michigan, Indiana, Illinois, Kansas, Texas, New Mexico, and Washington. The other species of the genus *Hydrophilus* occurring in the United States are *H. castus* Say, *H. lineatus* Lec., and *H. rickseckeri* (Horn). The two latter species seem to be confined to the most western states while the first is southern in its distribution. *H. castus* Say has been placed in the genus *Neohydrophilus* by d'Orchymont principally

on account of its emarginate fronto-clypeus while the other species are left in the genus *Hydrophilus* in the strict sense.

III. THE HEAD AND ITS APPENDAGES

Head Capsule (Figs. 1 and 2):—The head capsule of *H. obtusatus* Say is practically circular in outline, when viewed from above, and is somewhat slightly depressed although it is well rounded out. It is inserted in the prothorax as far as the caudal margin of the eyes so that the occiput and the caudal portion of the vertex is concealed. The *compound eyes* (e), which protrude from the sides of the head, are large and appear cordate from above, but being emarginate caudad are reniform when viewed from the side.

The *epicranial suture* (es) is distinct and almost attains the caudal margin of the vertex. Cephalad it extends along the median line to a point between the eyes, where it divides into a right and a left arm called the *antenno-frontal sutures* (afs) but also known as frontal sutures Each of these sutures curves outwardly, dips slightly caudad at a point near the eye. then passes in front of the eye to the lateral margin of the head, where it extends ventro-mesad and finally terminates near the dorsal condyle (precoila).

The two portions of the *vertex* (v), separated in part by the epicranial suture, are termed the *parietals* (pa) and each of these is set off at the side of the head from the postgena and gena by a poorly defined ridge. This ridge is continuous with the rounded posterior margin of the vertex and extends to the caudal region of the eye. A small shallow depression is present mesad near the hind margin of the vertex.

The *occiput* (oc) is not clearly demarked, and merges dorsad with the vertex. Two short, vertical grooves occur in the occipital region just laterad of the *occipital foramen* (of).

Each *postgena* (pg) has a shiny, glabrous, quadrangular area at the side of the head near its posterior margin. The cephalic margin of each *gena* (ge) follows the thumbprint-shaped caudal emargination of the eye and is continued along the caudo-ventral margin of the eye. It is a question as to just what constitutes the postgena. According to Stickney, 1923, each postgena is a

narrow area, bearing the acetabulum (postcoila) for the reception of the condyle of the mandible and is situated just laterad of the base of the submentum. I am inclined to consider, however, that the postgena is fused with the gena and that it really extends from the hypostomal region to the caudal region of the head, where it takes part in the formation of the occiput.

Immediately in front of each eye there is a small, triangular area which in this paper is termed the *parocular sclerite* (pl). It is called the "second sternite" or "antennal sclerite" by d'Orchymont, 1913, but, since I can not agree with his attempt to name the somites of the head, such terms do not seem acceptable until more definite proof of their origin can be presented. This parocular sclerite extends almost to the caudal margin of the eye as a narrow rim along the mesal side of the eye, and also laterad in front of the eye until it unites with a narrow, antennal sclerite which surrounds the base of the antenna. Such parocular areas are present in other species of the genus *Hydrophilus* as well as in the genera *Hydrous, Tropisternus, et al.*, but are most prominent in *Hydrophilus*. The short but well-defined suture demarking each parocular sclerite is named the *parocular suture* (pls). The setiferous punctures, which are present on these sclerites, together with those just caudad but separated off by the parocular sutures, are called the *interocular series* (is).

Each *frontal pit* is located near the end of the antenno-frontal suture just laterad of the dorsal condyle (precoila). The reason for such a location of the frontal pits is doubtless due to a deflection of the lateral margins of the head. The anterior articulations of the mandibles, as well as the frontal pits, have thus been forced to assume a ventral position rather than the more primitive, dorsal position as represented by Stickney, 1913, in his hypothetical type or even by the genus *Hydraena*, a member of the Hydrophilidæ.

The large, cape-shaped sclerite in front of the antenno-frontal sutures is a combination of the front and post-clypeus, namely the *fronto-postclypeus* (fp). This sclerite is folded over the sides of the head and is represented on the ventral side by two

triangular regions. The two series of setiferous punctures, each arranged more or less in a semicircle towards the sides of the head, are the *antero-lateral* series (as). Such an arrangement has been termed "lunate" by most authors and is quite characteristic of the species, although in some individuals the punctures are dispersed and often the two series are not entirely symmetrical.

The *anteclypeus* is not usually visible from above, but is a membranous area concealed beneath the cephalic margin of the fronto-postclypeus uniting it with the *labrum* (l). In the genus *Neohydrophilus*, including the American species, *N. castus* Say, the anterior margin of the fronto-postclypeus is so distinctly and broadly emarginate that d'Orchymont, 1913, designated as the clypeus (postclypeus) the membranous area occupying this emargination. Thus he considers the dorsal sclerite posterior to it the prefront (front). It is possible that this area really represents the clypeus but I am still inclined to call it the anteclypeus.

The *gula* (g) is bell-shaped, and as shown in Figure 9, is slightly indented at its cephalic margin. It lies between the postgenæ from which it is separated by the gular sutures and extends from the base of the submentum to the occipital foramen. The *gulo-submental suture* (gss) is continuous with the sutures which separate the postgenæ and the submentum. The *gular pits* (gp) seem to be present along the entire length of the gular sutures but are visible externally only near the cephalic end of the gula. The entire surface of the gula is minutely punctured and pubescent.

Endoskeleton (Fig. 9):—The right half of the tentorium is depicted *in situ* whereas the left half is laid over to the left in order to show its structure more satisfactorily. Each *anterior arm* (aa) has its origin in a frontal pit located near the dorsal condyle and extends in a caudo-ventral direction branching into two arms, one forming the *dorsal arm* (d) and the other uniting with the *posterior arm* (po). The dorsal arms end on the underside of the vertex near the posterior margin of the eyes while the posterior arms are extensive plate-like structures which

arise from the gular pits. The caudal expansions of the posterior arms form a sort of collar to the occipital foramen ventrad and laterad but are lacking dorsad. A small spine-like projection is present near the caudal margin of each posterior arm and each occipital condyle or *odontoid process* (od) is evidently represented by a minute sclerite in the membrane of the neck between each pair of lateral *cervical plates* (ip) and the collar of the posterior arms. The *body of the tentorium* (b) is very much reduced and is represented only by a slender transverse bridge connecting the posterior arms. A characteristic but small spine is directed forward from the middle of this bridge.

Labrum and Epipharynx (Figs. 1, 2, and 10):—The *labrum* (l), the most cephalic sclerite of the head, is about four times as wide as it is long. Its cephalic margin is rounded at the sides and is slightly emarginate mesad. A transverse row of setiferous punctures is present near the caudal margin of the labrum and the punctures are irregularly spaced and vary from ten to fourteen in number. A number of scattered setæ are also present at the sides of this sclerite. All the setæ of the labrum, however, are delicate and are often broken off except on fresh specimens. A narrow groove, parallel and slightly cephalad of the caudal margin, marks the attachment of the cephalic border of the *anteclypeus.* The *tormæ* are present as stout, chitinous projections of the caudo-lateral angles of the labrum and are directed caudo-mesad. At each of the caudo-lateral angles of the labrum there is attached a long tendon and these are associated with the muscles which raise and lower the labrum. The oral surfaces of the labrum and epipharynx are quite complicated in structure, and are invested with a variety of spines and setæ. Just inside of the concave margin of the labrum there is an elongate depression bordered in front by a row of about nine spinules (each of which is mounted on a tubercle), and behind by a row of six stout sense cones or blunt spines. At the base of each cone there is a triangular structure. The labrum and fronto-postclypeus are represented on each side by a narrow, sclerotized region which is an extension of their dorsal surfaces. At each side of the labrum there are two small sclerites, the

cephalic or larger one bearing a group of setæ while the caudal or narrower sclerite is bare and slightly concave. The rest of this area is entirely membranous except for the *epipharynx* (ep) which is a median, hairy, and somewhat cone-shaped structure.

Antennæ (Fig. 8):—The 9-segmented, capitate *antennæ* (ant) are inserted in depressions on the ventral side of the head just in front of the eyes. When at rest they are folded back and lie on the under side of the head just below and mesad of the eyes. The bulbular base of the scape fits into an antennal socket thus forming a ball-and-socket type of articulation. The first segment curves inwardly and is somewhat spinous towards its base. The second segment is more slender than the first and is about one-half as long, but it is slightly longer than the next three segments together. The sixth segment is asymmetrical, cone-shaped, and forms a calyx-like structure which receives the seventh segment, i.e., the first segment of the club. Slightly below its distal margin the inner face of the sixth segment is surrounded by a row of small tubercles, each bearing a slender, erect seta. The seventh and eighth segments are similar, tending to be concave on one side but swollen and broadened on the opposite side. The terminal or ninth segment is cordate, flattened, and stalked, as are the two preceding segments. The first six segments are yellowish to brownish and glabrous, whereas the last three, composing the club, are reddish brown and entirely pubescent.

Mandibles (Figs. 3–7, inclusive):—The *mandibles* (md) are not visible from above except when they are in action. Each mandible articulates with the head capsule on a dorsal condyle (precoila), located on the fronto-preclypeus just in front of a frontal pit, and in an acetabulum (postcoila), situated at the cephalic end of the postgena, by means of a mandibular *acetabulum* (ac) and a mandibular *condyle* (cn) respectively. The *abductor* (ab) and *adductor muscles* (ad), represented in the drawings by tendons, control the action of the mandibles. The mandibles are asymmetrical, although appearing symmetrical at first glance, and have sharply bifid tips, extensive *molar areas* (ma) and *spiniferous margins* (sn). The proximal

portion of the molar area is often termed the *submola* and the distal portion the *mola*, but these portions are not clearly defined in this species. The mandibles are stout and remarkably developed for grinding, rasping, and cutting food materials. They resemble more closely the primitive type of mandibles, present in the larvæ of such generalized hydrophilids as *Ochthebius* and *Hydræna*, than they do the more specialized type found in the mandibles of their own larvæ.

The broad, dorsal expansion of the molar area is best seen from a mesal view of the mandible (Fig. 4). The areas marked x are lightly sclerotized and their surfaces are corrugated. The *posteroir piece* (pp) of the mandible is covered with punctures in contrast with the impunctate *anterior piece* (ap). The color of the mandibles varies from piceus to reddish brown.

Maxillæ (Figs 11 and 12):—The brush-like maxillæ are doubtless very helpful in assisting the mandibles in handling food and each of these "under jaws," as they are sometimes called, consist primarily of a cardo, stipes, lacinia, galea, palpifer, and 4-segmented palpus. The subcordate *cardo* (ca) is the most proximal segment and bears two basal processes. There is a slight indication, just laterad of the outer basal process, of a division of the cardo into a *basicardo* and *disticardo.* The tendon of an adductor muscle is inserted on the larger, inner basal process and the tendon of an abductor muscle is attached to the outer process. That portion lying between the two processes functions as a pivot which is received by a small depression in the side of the submentum just cephalad of the caudolateral angle of the submentum.

The *stipes* is composed of three sclerites, the *basistipes* (bs), the *medistipes* (ms), and the *parastipes* (ps). The basistipes is shaped like a right angle triangle with its base contiguous with the distal end of the cardo and its perpendicular side adjacent to the medistipes along its entire length. The ventral surface and outer margin of the basistipes are rounded and covered proximad with moderately long setæ. The medistipes is notched near its base and, together with the parastipes from which it is weakly separated by a straight suture, forms a somewhat quad-

rangular area often called the *subgalea*. The mesal margin of the parastipes is concave and the *lacinia* (la), which lies mesad of it, bears a finger-like process or *digitus* (di). The distal margins of the digitus and lacinia are fringed with spines.

Cephalad of the parastipes is the cubical *basigalea* (bg), which is tipped with erect setæ. It bears mesad the *distigalea* (dg), a fan-like structure equipped with eight rows of curved setæ. A peculiar tubular process, arising near the base of the distigalea, is shown in the dorsal view of this region (Fig. 11). The *palpus* (mp) exceeds the head in length and articulates with a cup-shaped *palpifer* (pf) by means of a globular, basal segment. The other three segments are slender and successively shorter distad.

Labium and hypopharynx (Figs. 2 and 13):—The *labium*, sometimes called the "under lip," is attached to the distal end of the gula and postgenæ by means of the *submentum* (sm), which is nearly twice as wide as long. The submentum is shiny and practically flat except for a shallow, circular depression centrally located. This depression is characterized at its base by a triangular, pubescent area of minute punctures. The rest of the plate is only sparsely punctate and each puncture bears a small inconspicuous seta. The postero-lateral angles are somewhat extended laterad and are slightly notched. The *mentum* (mn) is also a broad, quadrangular plate quite similar to the submentum with which it articulates. Its ventral surface is covered with setiferous punctures. The *prementum* (pm) is the membranous area cephalad of the mentum and bears the *ligula* (lg) and the *palpigers* (plg). The *paraglossæ* (pr) and the conical, median *glossa* (mg) comprise the ligula. The paraglossæ appear on the ventral side of the ligula as two subovoid areas, each of which is flattened distad and surmounted by a group of long setæ which exceed the labrum. The sides of the paraglossæ are extended laterad and practically clasp the palpiger from above. Each of the palpigers bears a 3-segmented *labial palpus* (lp). The first segment is short, being about one-fourth the length of the second segment, which is slightly longer than the third. The second segment bears a row of setæ along its inner margin besides several other scattered setæ. Three

long setæ are borne laterally on the third segment, a short distance from the tip of the palpus.

The *hypopharynx* is an extremely complicated structure. Its central region is shaped like a triangle with an apex directed caudad. Long setæ are present at the sides of this area and they point inwardly. On each side is a less sclerotized region the surface of which is corrugated with longitudinal grooves. The *fulcrum hypopharyngeum* consists of two round plates lying below the caudal third of the hypopharynx and terminating caudad in two slender arms.

IV. THE CERVIX

Cervix (Figs. 14 and 20):—The *neck* (ce) is almost entirely membranous and is usually hidden by the overlapping margins of the prothorax. Dorsad, on each side of the median line, there is a small, transverse area consisting of sclerotized tubercles each of which bears a small seta. Two yellowish *lateral cervical plates* (ip) are present in each side of the neck and together they form a flat, slipper-shaped structure. The cephalic plate or *precervicale* (y, Fig. 20) is rounded at both ends, elongate, and bears cephalad a group of setæ, each surmounting a small tubercle. Just below this area a conical process of the plate is directed inwardly. The caudal plate or *postcervicale* (z, Fig. 20) is about one-third the length of the precervicale. It is pointed at both ends, and is shaped somewhat like a meatchopper. The postcervicale has a slender, dorsal arm which is twisted half way around. MacGillivray, 1923, termed the cephalic plate, the cervepisternum, and the caudal plate, the cervepimeron, since he evidently considered them to be homologous with pleural sclerites. The terms, jugular sclerites, cervical sclerites, and "prothoracic paraptera" have also been used as names for these plates.

V. THE THORAX AND ITS APPENDAGES

Prothorax (Fig. 14):—The dorsum or upper surface of the pronotum is convex, and is nearly twice as long as wide. It is distinctly margined at the sides but only slightly in front and in back. A very narrow groove is present inside the lateral

margins and a row of inconspicuous setæ arises from the bottom of the groove along its cephalic half.

The dorsal surface of the pronotum bears six characteristic groups of setiferous punctures which are fairly constant in number and arrangement. Each *antero-external series* is composed of two groups of punctures, an outer group of scattered punctures in the cephalo-lateral angle of the pronotum and an inner group arranged in a nearly straight, oblique line directed caudomesad. The *medio-external series* is scattered irregularly over a large subtriangular area, the apex of which points mesad.

The cephalic border is somewhat sinuate, being concave as a whole but slightly convex in the middle. All of the pronotal angles are rounded, the caudal angles more noticeably so. The entire pronotum is gradually broadened caudad and the width at its caudal margin is one-half again as wide as that at the cephalic margin.

The pronotum extends ventrad in all directions. The actual extent of the pronotum of insects was made considerably clearer by Crampton, 1926, and his interpretation is accepted in this paper. In front the ventral portion of the pronotum is not very extensive, forming only a narrow band, which is closely appressed to the under surface of the dorsum, and is recognized principally by an indistinct line demarking its caudal margin. Ventrad the sides and the lateral portions of the caudal margin of the pronotum reach the coxal cavities, apparently being either fused with the pleura, which are not clearly traceable, or represented by the inflexed regions below the margins of the coxal and trochantinal cavities in the vicinity of the *precoxal folds* (n).

A weakly defined but easily traced *subnotal suture* (in) divides the ventral portions of the pronotum at each side into the so-called *epipleuron* (ei) and *pseudopleuron* (pn). The epipleura are narrow and somewhat L-shaped regions. Each pseudopleuron seems to be divided by a short suture, arising from the lateral end of the trochantinal cavity, into two sclerites, which are often incorrectly designated the episternum and the epimeron.

In the region of the posterior foramen the ventral portion of the pronotum bends slightly cephalad and then caudad forming a horizontal groove and a narrow *shelf* (sh) upon which the anterior edges of the elytra rest. The caudal margin of the shelf is sinuate and fringed with short setæ except towards its sides.

The under side of the prothorax, just inside of the lateral margins, is concave, but mesad the prothorax is noticeably convex, the convexity being limited approximately to a region bounded by lines tangent to the sides of the foramina. The *basisternum* (ba) forms the anterior part of the sternum, and in front a portion of it is bent inwardly at right angles to the rest of the sclerite. The anterior edge of the basisternum is slightly margined ventrad, and the basisternum is prominently keeled along the median line. This keel is laterally compressed and is extended slightly forward as a blunt process. It is pointed caudad and forms a sharp angle with the surface of the *furcasternum* (fs). The lateral extensions of the basisternum are the *precoxal bridges* (pc) and they are separated from the pronotum at each side by the distinct *precoxal sutures* or *folds* (n). In addition to the pubescent hairs covering the basisternum, scattered setæ occur on the cephalic half of its ventral surface.

The furcasternum is just caudad of the basisternum and slants caudo-dorsad so that it is almost entirely concealed by the coxæ. It divides caudad into two, broad, flat arms, each of which passes beneath a coxa in a caudo-lateral direction thus forming the mesal wall of a coxal cavity, and unites with a mesal projection of the pseudopleuron, namely, the *postcoxal bridge* (px). The *furcal pits* (fu), which are situated about midway along the lower surfaces of the furcal arms near the inner margins of the furcasternum, lead to short, internal processes or furcæ. The pointed, mesal projections of the postcoxal bridges are practically contiguous.

Prothoracic leg (Figs. 15–19, inclusive):—When *in situ* the *coxa* (cx) appears to be globular, but when it is removed from the *coxal cavity* (cc) it is seen to be more ovoid than spherical in form. The entire surface of the coxa, except a basal process and a narrow, mesal area where the coxæ are contiguous, is pubescent. The dorsal (extensor) surface of the coxa is pro-

longed proximad into a *coxal process* (cp) which articulates with a bottle-shaped *trochantin* (tn) by means of a condyle. The trochantin is hollowed out near its proximal end and the sclerite is so divided at its base that two knob-like processes are formed. These processes are so attached to the hidden pleuron that each one of them apparently articulates on each side of a pleural suture. Stout tendons (Fig. 16, te), are attached to the coxal process and the trochantin in such a way as to permit the coxa to rotate freely.

The external relation of the second segment of the leg or *trochanter* (tr) to the coxa is best seen by a glance at Figure 17. The trochanter is an irregular segment but appears oval from below and is pubescent except for a small distal area cephalad and along the apical half of a ventral ridge. Internally two knobbed condyles (trochocondyles) arise from the dorsal surface of each trochanter and extends in opposite directions, i.e., cephalad and caudad, forming a sort of T-shaped structure each end of which articulates with a trochantifer of the coxa. The distal end of the trochanter is not strongly fused with the femur but it does not articulate freely, the union being more or less rigid.

The *femur* (fe) is about the same length as the coxa including the coxal process, and is nearly three times as long as its greatest width. The entire surface of the femur is sparsely punctate except where it is pubescent. Each puncture has a microscopic spine. The pubescence on the caudal side of the femur occurs only near its base, but in front it covers about two-thirds the distal half of the segment. The entire ventral (flexor) surface of the femur is hollowed out, but more noticeably so distad. The caudal surface is flat while the cephalic surface is convex.

The *tibia* (ti) is just as long as the femur if the *tibial spurs* (tis) are included but is more slender. The cephalic surface is distinctly convex whereas the caudal surface tends to be somewhat flattened. There are six, longitudinal rows of spines on the tibia, five of which are visible from a caudal view and the sixth from a cephalic view. The spines of the three middle rows of the caudal side and the row on the cephalic side are stout and conical while the other two or marginal rows (ventral and

dorsal) are flattened. These rows of spines give the tibia an appearance of a serrate margin. There are two prominent, angular, tibial spurs, the more dorsal of which is longer and stouter, and a row of flat spines surrounds the distal end of the tibia.

The *tarsus* (ta) is 5-segmented and bears terminally a pair of flat claws or *ungues* (cl). The tarsal segments with the exception of the first, are fringed dorsad with a row of slender setæ which are as long as the first segment of the tarsus. Each tarsal segment is grooved along its ventral surface and the grooves are bordered on each side with a row of short, flat spines. The claws are recurved, sharply pointed, and each one has a basal tooth. The basal teeth are acute in the female but are usually blunt in the male (Fig. 19). The claws are more strongly bent in the male, resembling grappling hooks. The pretarsal region is somewhat angular, giving each lateral portion an appearance of a subbasal tooth. Between the bases of the claw there is a slender, *cylindrical process* (pt), which possibly represents a ventral projection of the pretarsus. This process is sclerotized and bears distad two or three long setæ.

Mesothorax (Figs. 21 and 22, in part; and 24–27, inclusive):—Dorsally the *prescutum* (psc) is small and triangular, the base of the triangle being in line with the cephalic margin of the mesonotum and the apex attaining the anterior margin of the scutellum The major portion of the prescutum is inflexed over the deeply emarginate, cephalic margin of the mesonotum. For a short distance it slants in a caudo-ventral direction and then flattens out forming an internal shelf. The prescutum is so folded along the median line of this shelf that it forms a blunt, laterally compressed, spine-like process. The lateral portions of this internal shelf are subtriangular and extend caudo-laterad as far back as the posterior margin of the *scutum* (sc). The caudal extensions of the prescutum are apparently inflexed again and closely applied to the ventral surface of the shelf. At the cephalic border of the shelf this secondary inflection flares ventrad and cephalad forming a pair of narrow, lateral wings which constitute the *prephragma* (Fig. 25, ph).

The dorsal surface of the *scutellum* (sl) is a prominent, triangular, raised area and, in keeping with the rest of the upper surface of this species, is minutely punctate and shining. It is approximately equilateral and extends below on all sides, slanting mesad as far as the triangular region shown in Figure 25 by interrupted lines. In front, just below the margin of the scutellum, there is a row of short setæ.

The *scutum* (sc) is divided into two irregular areas by the prescutum and scutellum. Each of these lateral areas extends from the cephalic margin of the mesonotum to the anterior margins of the *parascutella* (prs). Cephalad the scutal regions are pubescent and somewhat arched. The slender antero-lateral extensions of the scutum are known as the *prealar bridges* (prt). The prominent lateral angles, two on each side of the scutum, are the anterior notal processes or *suralares* (anp) and the posterior notal processes or *adanales* (pnp) which support the elytra. On each side just below the region of the two notal processes is a round concavity, the diameter of which is equal to the distance between the processes. The margin of the scutum between the adanale and the parascutellum is noticeably notched above and concave laterad.

At each side of the notum, arising as a lateral extension of the arm-like parascutellum, is an *axillary cord* (axc). Near the base of each axillary cord, a narrow projection, apparently a remnant of a *postalar bridge* (pb), is given off from the caudal margin of the parascutellum and extends in a latero-ventral direction. The parascutellum is slightly concave in the region adjacent to the scutellum.

The *postscutellum* is continuous with the caudal margins of the parascutellar sclerites but is so inflexed that it lies entirely beneath the mesonotum and its caudal margin extends as far forward as the cephalic limits of the parascutella (indicated by dotted lines). The postscutellum is slightly sclerotized and would be called triangular in shape except for the fact that it is truncate and emarginate caudad.

The pleural and sternal regions of the mesothorax are better developed than the tergal portions and are quite rigidly united with the corresponding portions of the metathorax. The

cephalo-lateral angles of the mesosternum and the cephalic regions of the pleura are rather complex so that it is a difficult proposition to name the parts with certainty. These areas are hollowed out for the reception of the cephalic portion of the lateral margin (lm), the apophysis (ae), and the notale (nt) of each elytron. It is very likely that the dorsal side of the lateral margin, a narrow ridge, represents the *alifer* (wing process, wp) and that the ventral side, a projection rounded laterad and bent dorsad, is the anepisternum but one can not be positive.

The cephalic margin of each pleuron is bounded by a transverse, emarginate sclerite, the *prepectus* (pe). These sclerites are narrowly separated mesad by the basisternum (ba). Laterad each prepectus bears a flat, triangular process projecting forward from its cephalic margin. The name of this process, as well as its function, is a question but it may be of value in supporting the *mesothoracic spiracle* (sp 1), which lies in the intersegmental membrane just in front of the process. A group of setæ is present ventrad on the pro-mesothoracic intersegmental membrane between the two spiracles. Internally each prepectus is represented in front by a narrow inflexed portion, which is closely applied to its surface. The suture, which separates the caudal margin of each prepectus from the katepisternum (ket), is sinuous.

As usual the pleural suture divides each pleuron into an episternum and epimeron. When either the episternum or the epimeron is divided into an upper and a lower region, the prefixes "an" and "kat" are used respectively to denote such regions. These terms were first proposed by Crampton, 1909, and he also discusses their usage in a later paper, 1914.

The *katepisternum* (ket) or lower portion of the episternum is the largest sclerite of the pleuron and is somewhat quadrangular, although its inner side is convex. The *pleural suture* (su) evidently originates at the cephalo-lateral angle of the prepectus, and as a faint ridge extending caudad forms the lateral boundary of the prepectus. It passes caudad along the side of the body until it reaches a point about half way along the mesal margin of the anepimeron (aer). Then it takes a direction almost at right angles to its previous course and travels caudo-

mesad, finally dividing the *coxifer* (Fig. 21, cf) and attaining the *coxal cavity* (c.c).

The *katepimeron* (ker), the lower portion of the epimeron, is about one-third the size of the katepisternum and irregular in shape. It is emarginate behind and slightly conceals the cephalic margin of the metathoracic katepisternum (ket). Ectad the *anepimeron* (aer) or upper portion of the epimeron is triangular in shape and its broad base borders the katepisternum and katepimeron laterad. An internal view of the anepimeron (Fig. 21, aer) shows that dorsad it is reflexed for a short distance and tends to cover the inner surface of the katepimeron (ker).

The *basisternum* (ba) extends from the cephalic margin of the mesosternum caudad to a point between the *coxæ* (cx) almost in line with their caudal margins. The basisternum is prominently keeled along the entire median line and is interlocked at its caudal extremity with the *metasternal keel* (mek). The *mesosternal keel* (msk) is right angled in front and compressed laterad for about one-fifth its length from the cephalic margin. The remaining portion of the keel is rounded below except in front where it bears a small, round tubercle. The sides of the keel slope gradually and each side takes the form of a triangular area extending as far laterad as the inner margin of the katepimeron, thus forming an *antecoxal bridge* (pc). The *furcasternum* is entirely concealed below the outer surface of the mesosternum but is seen at the cephalo-mesal margins of the coxal cavities when the *coxæ* (cx) are removed. When the sternum is viewed from within it is seen that the *furcal arms* (Fig. 21, ft) constitute the most evident endoskeletal structures of the mesothorax. These arms are slender, rod-like processes, one on each side, arising from the *furcal pits* (fu), located at the cephalo-mesal angles of the *coxal cavities* (cc). Each one extends dorsad in a cephalo-lateral direction to a region between the episternum and epimeron where it flares out like a trumpet to form a terminal muscle disc. The furcae are somewhat flattened near their origin and are united with each other ventrad by a short bridge. The caudal surface of each furca bears a muscle disc a short distance from its base. The cephalic mar-

gins of the *precoxal bridges* (pc) and the sides of the *basisternum* proper (ba) are invaginated, forming on each side a subtriangular shelf, the caudo-mesal angle of which extends caudad to the base of the furcal arms.

A peculiar infolding or *apodeme* (ag) occurs along the upper margin of each katepisternum and extends from a region near the end of each furcal arm to the caudal margin of the prepectus where it terminates in a finger-like projection. The peritreme or sclerotized area around the *metathoracic spiracle* (sp 2) is shown in its normal position just inside the katepimeron (ker).

Elytra (Figs. 24, 26, and 27):—The elytra cover the entire dorsal surface of the body behind the caudal margin of the pronotum with the exception of the mesoscutellum. They are strongly convex and closely follow the general contour of the body. The length of each is about two and a half times its width. The *scutellar margins* (slm) of the elytra are contiguous with the mesoscutellum, and when at rest the posterior or *sutural margins* (pi) of the elytra are interlocked, a narrow ridge of the right elytron fitting into a groove of the left elytron. The proximal and anterior or *lateral sides* (lm) of the elytra are margined.

Each *apophysis* (ae) of the elytron articulates by means of an axillary plate, the *notale* (Figs. 22 and 24, nt), with the concavity at the cephalo-dorsal angle of the mesopleuron. There are eleven longitudinal rows of small punctures, which are faintly visible on the upper side of each elytron, and four or more longitudinal rows of larger, setiferous punctures. The first two rows of the smaller punctures unite about one-third the distance of the length of the rows from the proximal margin and the eighth and ninth rows form a single row for a short distance from the base of the elytron and then separate.

When viewed with a hand lens, there appear to be about four rows of distinct punctures and these are comprised of the larger, setiferous punctures just mentioned. They lie between the third and fourth, fifth and sixth, seventh and eighth, ninth and tenth rows, and laterad of the eleventh row of smaller, indistinct punctures. The third row is somewhat irregular and missing

proximad while the fourth row is also irregular and really composed of two or more confused rows.

The latero-proximal angle of each elytron bears an oblique row of setiferous punctures and a few, delicate setæ. A number of spine-like setæ are scattered along the proximal margin and the ventral surfaces of the inflexed margins are covered with a stiff pubescence except for a narrow strip along the lateral margin.

A delicate membrane lines the inside of the elytron. The small, dorsal punctures are represented ventrad by short rod-like projections but the larger punctures are not extended below and appear as small pin-holes.

The *jugalula* (Figs. 24 and 26, al) is a small, flat, membranous, sac-like appendage attached laterad to the inflexed, basal margin of each elytron, and to a small, articulating ossicle, the *notale* (nt). The notale fits into the cavity of the *elytral apophysis* (ae) and serves as an intermediate articulating ossicle between the apophysis and a cavity in the mesopleuron. The notale is somewhat hammer-shaped, and it is possible that its claw-like base may be composed of more than one axillary sclerite. The jugalula appears to be slightly sclerotized proximad and along its *elytral* (em) and *notal margins* (nm). The jugalula is reversed in position when it is folded back against the body, in which position its dorsal surface lies next to the notum. The *axillary cord* (axc), which originates as a part of the caudal margin of the parascutellum, extends to the notal margin of the jugalula near its base.

A small muscle, represented in Figure 24 by a *muscle disc* (mu) and a tendon, is attached to the jugalula mesad of a small, triangular *axillary sclerite* (i), while another larger sclerite, probably the *basanale* (be), lies on the dorsal surface of the jugalula just laterad of the small axillary sclerite (i).

Mesothoracic leg (Fig. 29):—The mesothoracic leg is somewhat longer than the prothoracic leg, the principal difference being in the greater length of the mesothoracic tarsus. The elongate, subtriangular *trochantin* (tn) is inserted in the cephalic face of the coxa and is only visible externally for about half its width. The portion, in front (ventrad) of a longitudinal ridge, is concealed beneath the precoxal bridge (pc).

The *coxa* (cx) is conical but its dorsal half, except distad, is flattened cephalad (below) and margined along its cephalo-dorsal edge. It is deeply emarginate where the trochantin replaces its cephalic face ventrad (flexor surface). The coxa is more or less fixed in a transverse position with its distal end directed mesad and rotates only on its longitudinal axis. Both the coxa and trochantin are entirely pubescent and the trochanter is pubescent except for a triangular, apical area on its cephalic face.

The *trochanter* (tr) is a small, irregular, compressed segment and is practically fused to the femur. The method of articulation is similar to that occurring with the prothoracic trochanter.

The *femur* (fe) is nearly three times as long as its greatest width and is about the same length as the tarsus. It is laterally compressed, rounded dorsad, and grooved ventrad. This ventral groove is shallow and flattened at its bottom and becomes deeper and wider distad. The caudal surface is smooth and bears only an occasional puncture but the cephalic and dorsal surfaces are entirely punctate, each puncture bearing a microscopic spine.

The *tibia* (ti) is shorter, more slender than the femur, and its caudal surface is flattened. The caudal spur is nearly half again as long as the cephalic and almost as long as the first two tarsal segments. The rows of spines are not clearly defined but there are about eight longitudinal rows, only two of which are caudal, and these are practically marginal. Cephalad the tibia is fringed distad with a row of stout spines, while caudad and set back from the distal margin there is a curved row of slender spines.

The *tarsus* (ta) is the longest portion of the mesothoracic leg and each of its five segments, except the first, bears a dorsal fringe of long setæ (swimming hairs) which vary distad in length from approximately 2.0 mm. at the base to 0.45 mm. The second segment is about twice as long as the first and is equal to the third and fourth together. The terminal segment exclusive of the claws, which are half as long again, is three-fourths the length of the second segment. All of the tarsal segments except the first are grooved ventrad along their entire length,

and the grooves are bordered on each side with a row of short, flat spines. There is a slight indication of a ventral groove on the first segment due to the presence of two distal rows of flat spines. This segment is deeply emarginate above and the base of the second segment fits into this emargination, the rest of the first segment tending to clasp the base of the second. The entire tarsus is laterally compressed.

The *claws* (cl) are similar to those of the prothoracic legs. The secondary sexual characters are not so pronounced, although the basal tooth is usually blunt in the male. Each claw has a subbasal and basal tooth and the usual *pretarsal process* (pt), which bears two or three apical setæ, is present.

Metathorax (Figs. 21 and 22, in part; and 23):—The *metanotum* is twice as wide as long and is quite complicated in structure. The *prescutum* (psc) is divided into a cephalic surface, which extends downward at nearly right angles to a more caudal or dorsal surface. The cephalic surface of the prescutum is somewhat semicircular, lightly sclerotized, and bears two, small, semicircular flaps, the *prephragma* (ph) on its ventral margin. The meso-metathoracic intersegmental membrane is attached to the caudal margin ("antecostal suture") of the cephalic region of the prescutum so that this region is entirely internal. Some authors consider that this cephalic surface of the prescutum is the prephragma.

The dorsal surface of the prescutum (psc) is cape-shaped, strongly arched, and its heavily sclerotized, lateral portions are separated by an almost membranous median area. This central area is broad and reaches from the so-called antecostal suture caudally to the cephalic margin of the scutellum (sl). The latero-cephalic prolongations of the prescutum form the *prealar bridges* (prt) and the lateral end of each bridge is rolled up and also has a ventral, spine-like projection, the tip of which is barely discernible from above, but may be seen in Figure 23 just mesad of the rolled-up area.

When in position the prescutum is almost entirely covered by the caudal portion of the mesothoracic dorsum, and the apex of the mesoscutellum attains the cephalic margin of the median groove (me).

The *scutum* (sc) constitutes the main part of the mesonotum, and is separated mesad by the scutellum (sl) into two subquadrangular areas. There is a tendency for each of these lateral areas to be divided in the region of a narrow, pubescent band into a cephalic and a caudal portion. This band is more or less included between the two dotted, transverse lines shown in Figure 23. The cephalic of these two areas is roundly elevated and slightly higher than the caudal area, and attains the lower level of the caudal area just behind the pubescent band. Each cephalic scutal region bears a pubescent, mucronate tubercle laterally.

An *anterior pronotal process* (anp) projects from beneath each of the cephalo-lateral angles of the scutum, and is a conspicuous, flat, trapezoidal structure slightly emarginate distad. The first axillary sclerite or *notale* (nt) lies just laterad of the anterior notal process. It is an irregular sclerite with a neck-like process, which extends cephalo-laterally to the base of the subcostal vein of the hind wing. At the side of the notale, and lying slightly beneath it, is another irregular sclerite, the secondary axillary sclerite or *median ossicle* (mo). This ossicle is probably composed of a proximal and an intermediate median ossicle and its lateral margin is shaped somewhat like a thumb and forefinger in outline, the cephalic or finger-like process of which is continuous with the base of the radial vein.

Each lateral margin of the scutum is noticeably indented so that, together with the caudal margin of the notale, an oval, membranous area is enclosed. The third axillary sclerite or *basanale* (be) is attached to a small flap of this area in such a way that an elbow-like projection fits into the scutal indentation when the wing is at rest. The basanale is an angular sclerite, the lateral margin of which is attached to the anal region of the hind wing, while its inner margin is contiguous with the side of the dorsum.

The cephalic margin of the *posterior notal process* (pnp) forms the caudal margin of each lateral indentation of the scutum and its lateral margin, where it unites with the basanale, is entirely straight. Just below the anal region of the wing in this area, a large, flat, suboval sclerite, the *subalar plate* (sul) is

more or less embedded in the membrane. A large muscle disc is attached to its inner surface.

Two, convergent, *scutellar ridges* (sr) extend from the cephalic margin of the scutum nearly as far back as the caudal margin of the scutellum (sl). The ridges are so folded over mesad that each forms a groove which serves to receive the inflexed margin of an elytron.

The *scutellum* (sl) is the subtriangular sclerite between the two scutal areas. It would be difficult to describe all of its limits because it is so closely united to the scutum. The arms of the scutellar ridges are doubtless formed from the scutellum although continuous with the scutum. Between the scutellar ridges is a *median groove* (me) upon which the inflexed sutural margins of the elytra rest, thus allowing the elytra to fit flush with the raised portions of the dorsum. Certain regions, where the scutum and scutellum unite, are so invaginated that they form an X-shaped, centrally located, internal structure called the *endodorsum* (ed). The caudal margin of the scutellum is undulating and slightly lobed just behind the median groove.

The *postscutellum* (psl) is a narrow sclerite contiguous with the caudal margins of the scutellum and the scutum. It extends entirely across the dorsum and its projecting lateral arms are the *postalar bridges* (pb). Along the cephalic margin of the postscutellum, just caudad of the scutellum, is a narrow membranous area shaped in outline like a bird with outstretched wings. Caudad the postscutellum is bent perpendicularly downward, forming internally a transverse *postphragma* (pph), the lateral ends of which bear a prominent muscle disc. The postphragma is divided on each side, about midway between the median line and the muscle disc, by a longitudinal fold in the postscutellum. The broken line in Figure 23 indicates the caudal limit of the postscutellum as well as the basal line of the postphragma. The narrow region behind this line probably represents an isolated portion of the first abdominal tergite.

The *metapleuron*, except for the katepisternum and the caudal end of the katepimeron, is concealed from view by the elytron. When viewed from below the *katepisternum* (ket) is subovate with its caudal end somewhat narrower than its cephalic. It

is almost three times as long as it is wide and extends lengthwise from the posterior margin of the mesepimeron to the metathoracic coxa (cx). The caudo-dorsal angle of the katepisternum has been bent upward for a short distance and then ventromesad, forming with a caudo-ventral portion of the katepimeron (ker) an *internal,* triangular *shelf* (ks). The original pleural suture has naturally been carried internally with this invagination so that the external line of demarkation, which divides these two sclerites and which I have called the *pleural suture* (su), is really not a true pleural suture.

The *anepisternum* (aet) adjoins the cephalo-dorsal angle of the katepisternum and is a slender arm-like sclerite which forms the cephalic portion of the *wing process* (wp). The *katepimeron* (ker) is the narrow, curved sclerite contiguous with the dorsal margin of the katepisternum. Caudad it is emarginate where it borders the coxal cavity and its caudo-dorsal angle is pointed. The cephalo-dorsal angle of the katepimeron is noticeably emarginate where it is replaced by the *anepimeron* (aer). The suture dividing these two portions of the epimeron is poorly defined but the division may be clearly recognized by the fact that the lower portion of the anepimeron is only lightly sclerotized in contrast with the more heavily sclerotized katepimeron. The anepimeron is sharply bent at the side of the body and extends to the dorsal surface of the insect. This dorsal portion is subtriangular and its apex is more heavily sclerotized than the rest of the sclerite, especially between the dotted lines shown in Figures 21 and 22.

The caudal or upper portion of the wing process (wp) is a slender extension of the anepimeron and it can be plainly seen from the internal view that the true pleural suture really divides the wing process into the episternal and epimeral portions since it takes a direct course to the *pleural coxal process* (cf). Above the wing process and attached to the anepisternum near its base is a large *muscle disc* (mu).

The *subalar plate* (sul) is shown in the membrane of the dorsal side of the body just mesad of the anepimeron, and the line of attachment of a muscle disc on its ental surface is represented by a broken line (Figure 22). The *first abdominal spiracle*

(sp 3) is shown just behind the *postalar bridge* (pb), which intervenes between the spiracle and the anepimeron.

The largest sclerite of the entire *sternum* is the *basisternum* (ba) of the metathorax. It extends from the inner margin of the katepisternum on one side in a ventro-mesal direction to the median line, and then in the reverse direction to the inner margin of the katepisternum on the other side. Each lateral portion is somewhat quadrangular but in front it is concavely emarginate since it follows the contour of the mesothoracic coxa. Mesally the basisternum bears a stout, ventrally flattened *keel* (mek), which is slightly grooved along the caudal half of its median line, not including the terminal *"metasternal spine"* (mts). This spine is compressed towards the tip and has a sharp, longitudinal ridge below. It does not extend beyond the hind coxæ (cx), in contradistinction to the condition occurring in such genera as *Hydrous* and *Tropisternus* in which the spine is noticeably prolonged.

The *furcasternum* (fs) is represented by two transverse sclerites, commonly called the antecoxal pieces or precoxal bridges. The cephalic margins of these sclerites, together with the caudal margins of the basisternum on each side of the keel, are invaginated to form a flat, narrow apodeme. The caudal margins of these furcasternal sclerites are reflexed, closely appressed to the inner surface of the furcasternum, and extend forward as far as the cephalic margins of the furcasternum.

The body of the *furca* (fs), a stout and deeply 4-grooved, internal structure, arises at the posterior end of the metathorax just above the metasternal spine. It extends in a cephalo-dorsal direction giving off two latero-dorsal arms, each of which bears two prominent muscle discs. One of these muscle discs is terminal while the other occurs just before the tip. The furca is of such a length that, if it were laid down flat on the metasternum, its most cephalic, 3-pronged tip would attain the base of the mesothoracic furca. The base of the furca is divided mesally so as to form two, longitudinal processes or *furcal condyles* (cn), upon each of which the ventro-mesal acetabulum of each coxa articulates.

The *wings* (Fig. 28) :—Forbes, 1922, aptly described and discussed the venation of the Hydrophilidæ, which he placed in

accordance with Gahan's system (1911) in the Palpicornia (Ganglbauer). He included the wings of *Hydrous triangularis* Say, *Hydrocharis* (*Hydrophilus*) *obtusatus* Say, and *Sphæridium scarabæoides* L. among his figures. For some reason or other, Forbes failed to figure the veins, present at the tip (apical veins) of the *Hydrophilus* wing, with the same degree of detail as he did in the case of *Hydrous*. The apical veins are weakly defined in *Hydrophilus*, to be sure, but are just as weakly defined in *Hydrous*. If viewed under the proper kind of illumination and from the right angle, one can not fail to observe a venation similar to that which Forbes depicted in *Hydrous*. It may be possible that he really saw the apical veins of *Hydrophilus* but considered them to be too indistinct to figure. The fact that he bases the apical venation of his hypothetical type on *Hydrophilus* suggests that he may have really recognized the condition in *Hydrophilus obtusatus*. However, he used the generic name, *Hydrocharis,* in discussing *Hydrophilus obtusatus*.

In general, Forbes' ideas relative to the naming of the veins seem to be well founded and I have therefore accepted his interpretations in this paper. Nevertheless, I have been forced to borrow the names, which he used for *Hydrous*, in labeling certain of the veins of *Hydrophilus*, more particularly the branches of *Radius* (R) and *Media* (M). There may be some question regarding the vein which I have designated as R_4. Forbes apparently calls this vein R_3 in his figure of the wing of *Hydrophilus* (*Hydrocharis*). However, if one refers to Forbes' accurate drawing of the *Hydrous* wing it will be seen that R_2 is fairly well defined. This R_2 seems to be represented in *Hydrophilus* by the stub-like vein towards the base and posterior to R_1. If then this stub-like vein is R_2, then the next fairly well defined vein, posterior to R_2, is probably R_3, and in turn the one which Forbes called R_3 is really R_4. In *Hydrophilus* R_4 and R_5 fork clearly, as is shown in Figure 28, so I believe R_4 is properly located.

The Palpicornia have a complex apical venation and Forbes states that it is the only group of Coleoptera with a complex apical venation. Moreover, it is apparently the only polyphagan group which preserves traces of the radial cell beyond the trans-

verse fold. The preservation of M_4 and Cu as separate veins is important since such a condition tends to link the Palpicornia with the lower Adephaga. One of the anals ($2A_1$) is always lost.

Both Tillyard and d'Orchymont have contributed important views relative to the hydrophilid venation. Tillyard, 1926, states that the closed cell present in the Adephaga between *Media* (M) and *Cubitus* (Cu), namely the oblongum, is absent in the Polyphaga and calls the formation, which replaced it, the apertum. The incompletely chitinized vein, *Media* (M), is called by Tillyard the "returning vein." In *Hydrophilus obtusatus* the apertum is well developed and the cross vein, cu–a, is noteworthy.

The folding of the polyphagan wing when at rest was very nicely worked out by d'Orchymont, 1921, who some years ago kindly forwarded me a reprint of his paper, together with an interesting paper model. The important folds, which occur in the hydrophilid wing, include the convex anal and median folds, the concave median furrow, and the transverse folding according to d'Orchymont. Forbes, 1922, gives a diagram showing the folding which occurs in *Hydrous triangularis* Say. I have not figured the folding pattern of the *Hydrophilus* wing since I find it similar to the folding in *Hydrous*. According to Forbes "the folding at the costal margin is as in the Adephaga while the remainder of the wing is almost typically polyphagan."

Metathoracic leg (Fig. 29):—The metathoracic leg is by far the longest of the legs, each segment being as long or longer than any corresponding segment of the other legs. The trochantin is not present but the *coxa* (cx) is exceedingly well developed, the two coxæ together spanning the entire ventral side of the body included between the lateral margins of the elytra. The coxa is about four times as long as it is wide and it can rotate only forward and back on its longitudinal axis. Articulation is by means of the pleural *coxal process* (Fig. 21, cf) and the *furcal condyle* (Fig. 21, cn), which fit into a ventro-lateral (proximal) and ventro-mesal (distal) acetabulum respectively. The caudal surface of the coxa is convex, and, when at rest, lies entirely below the level of the ventral surface of the body. The flat, cephalic surface of the coxa is flush with the under side of

the body. It is attached to the posterior surface of the thorax along its ventral (flexor) face. A longitudinal ridge is present along the ventral margin of the cephalic surface of the coxa and the dotted line, shown in Figure 30, indicates its dorsal limit. The coxa is entirely pubescent while the trochanter (tr) is pubescent except for a triangular, apical area on its cephalic face.

The *trochanter* (tr), *femur* (fe), *tibia* (ti), and *tarsus* (ta) are practically identical in structure with the corresponding parts of the mesothoracic legs. The trochanter is not quite as strongly compressed as the mesothoracic trochanter. The femur, which is nearly as long as the coxa (cx), is slightly more than twice as long as its greatest width. Some individuals seem to show less punctuation on the cephalic surface of the femur but still others agree in punctuation with the mesothoracic femur. The *tibial spurs* (tis) are slightly longer than those of the mesothoracic legs, the caudal spur attaining the distal margin of the second tarsal segment, but they bear the same ratio to each other.

The *tarsus* (ta) is exactly the same length as the mesothoracic tarsus and agrees in all of the essential details except that it appears somewhat stouter in certain individuals and the first segment is better defined.

VI. The Abdomen and its Appendages

The *abdomen* (Figs. 31–38, inclusive):—Ten abdominal segments are represented in this species, and, when retracted, their length is about two-fifths of the entire length of the insect. The abdomen is entirely covered dorsally by the wings, which lie under the elytra. Normally there are five visible sternites (s 3–s 7) and the removal of the wings reveal eight tergites (t 1–t 8) and five pleurites (p 3–p 7). The first sternite is missing and the second is hidden beneath the metathoracic coxæ. The eighth abdominal segment is so attached to the seventh by an intersegmental membrane that it can be retracted within the seventh segment in a telescopic manner. In a similar way the ninth segment, which contributes the main portion of the genitalia, is capable of being retracted within the body when at rest. The dorsum is convex and tends to be keeled along the median

line while the venter is somewhat concave at the sides but convex mesad. The abdomen of the female is noticeably broader and less acute caudad than that of the male and the cephalic margin of the eighth sternite of the female is more strongly lobed than that of the male.

Tergites (t):—The first six tergites are soft and slightly sclerotized while the seventh and eighth tergites are fairly well sclerotized, due possibly to the fact that they are more often extended beyond the tips of the elytra. Each of the second to sixth tergites has a setiferous, punctate, transverse area across its caudal half and bears a shallow, round pit just inside its lateral margin.

The exact limits of the tergites are somewhat difficult to locate, especially when the abdomen is boiled in caustic potash, because of transverse thickenings, one of which extends nearly across each of the second to sixth tergites (Fig. 32, dotted lines). The actual segments are delimited by intersegmental membranes, which cause the tergites to appear as folds. The remnant of the first abdominal tergite (Fig. 23, rt), attached to the metathoracic postscutellum is not shown in Figure 31. The rest of the first tergite, separated from the remnant by an intervening membrane, is narrow, roundly notched in front, and deeply emarginate laterad. The two, lateral, sclerotized flaps are characteristic of this tergite. The second tergite is the widest (cephalic to caudal) and longest (side to side) of all the tergites and is chiefly characterized by a thickening across its cephalic third. Towards each side this thickening curves in a cephalo-lateral direction and ends at the cephalo-lateral angles. On each side of the median line two short arms of the thickening extend caudad.

The third to eighth tergites, inclusively, become narrower and shorter caudad, the fourth, fifth, and sixth being approximately equal in width. The seventh and eighth tergites are minutely punctured and pubescent and the seventh tergite has an almost bare, suboval, raised area about one-half the distance between the median line and each side of the tergite near its cephalic margin. A narrow region along each side of the eighth tergite is sparsely pubescent and the sides are slightly inflexed.

Pleurites (p) :—The *pleural membrane* (plm) unites the outer margin of the tergites with the inner margin of the pleurites and is continuous with the intersegmental membranes. These sclerites merge indistinguishably with the pleural membrane and their limits are not always clearly demarked. The pleurites are narrow, pubescent, sclerotized regions, lying adjacent to and above the sternites, and occur on the third to seventh abdominal segments.

Sternites (s) :—The entire ventral surface of the abdomen (venter) as well as the dorsal extensions of the second to seventh sternites, inclusive, are pubescent. The second sternite is narrow, slightly sclerotized ventrad but is represented laterally and dorsally by a small, fairly well sclerotized semi-thimbleshaped sclerite (s 2).

The third sternite is reflexed and noticeably hollowed out on both sides to form the caudal portions of the metathoracic coxal cavities. A divided, median keel is formed between the two cavities and this tends to separate the coxæ. The sternites become gradually shorter caudad and the fourth to sixth, inclusive, are subequal in width. The cephalic margin of each sternite, except the second and third, slightly overlaps the caudal margin of the preceding sternite (see broken lines in Figure 31). The caudal portion of the seventh sternite is reflexed and closely appressed to its upper surface. This reflexed surface is glabrous and shiny except at its caudal margin, where it is pubescent.

Genitalia:—In this species the genitalia consist of portions of the ninth abdominal segment although some morphologists would probably include the eighth. The eighth segment has therefore been figured together with the genitalia proper in order to show its relationship to the other terminal abdominal segments. The interpretation of the genital structures of the Coleoptera is still somewhat of a problem although steps in the right direction have been taken by Sharp and Muir, 1912; Newell, 1918; Muir, 1924; Pruthi, 1924a, b; and Tanner, 1927.

In general the views of Sharp and Muir, 1912, for the male, and Tanner, 1927, for the female, have been accepted for this paper. The main difficulty has been relative to the location and proper naming of the tenth tergite. Newell, 1918, separated the

dorsal plate, which I call the ninth tergite (t 9), into a ninth and tenth. It is possible that some portion of this sclerite is really the tenth tergite, but I can not see any good reason for naming the slightly sclerotized portion of this tergite the tenth tergite, as Newell does.

Pruthi's excellent treatises, 1924 a and b, on the postembryonic development of a tenebrionid have helped materially in deciding the homologies of the various genital appendages as well as the questions concerning the position of the tenth tergite. Pruthi interprets the anal segment as the tenth, as does Muir, 1924, and this seems the most logical conclusion.

Female (Figs. 33–35, inclusive):—The *ninth tergite* (t 9) is a somewhat circular plate, concavely emarginate in front and with a large, slightly sclerotized, more or less central area. The heavily sclerotized lateral arms of this sclerite almost touch each other caudad. According to Newell, 1918, this central area represents the tenth tergite while Tanner calls the entire plate the proctiger, which morphologically is the dorsal plate of the tenth or anal segment.

On each side of the ninth tergite is the subtriangular sclerite or *surstylus* (ss) of Crampton, 1929. These were called the paraprocts by Tanner, but since they are really appendages of the ninth segment can not be so termed. The surstyli are slightly sclerotized caudad and are connected ventrad to the "*valvifers*" (vf) by a bridge which is only slightly sclerotized caudad. According to Crampton, 1929, the so-called "valvifer" in some Coleoptera may be a detached portion of the coxite (c). It is an irregular sclerite which is notched caudad. This *notch* (vn) fits over the coxite in such a way that it forms an articulation point (pivot of Balfour-Browne, 1909).

The *coxite* (c) is composed of two portions, a basal, irregular portion and a slender, finger-like, apical portion, which bears a terminal stylus. The *stylus* (st) is cylindrical with a recurved apical seta. Ventrad the *ninth segment* is terminated by a structure which Balfour-Browne, 1909, called the *ventral grooved plates* (vp). These plates form an apparently paired structure the parts of which are fused along the median line and are grooved dorsally to receive the coxites when at rest. The

plates are slightly sclerotized except for a narrow lateral band near their base and for the region along the ventral median line, but even these areas are not heavily sclerotized. The caudal margin of each groove is bordered with fairly long setæ.

According to Balfour-Browne, 1909, muscles attached dorsally to the bases of the spinnerets (coxites and styli) draw back the spinnerets and they pivot on the "valvifers." In the state of rest the spinnerets are concealed for about one-half their length by the immovable grooved ventral plates.

Male (Figs. 36–38, inclusive):—In the male there is a *dorsal plate* (t 9) similar to the one present on the ninth tergite of the female. The main difference in this dorsal plate depends upon the fact that, in the male, it is united with the lateral plates of the ninth abdominal segment. Each lateral plate extends below and is joined by means of a *cephalo-ventral arm* (h) to the posterior end of an *eversion rod* (vr) lying in the *connecting membrane* (cm) on each side of the ninth sternite (s 9). The *ninth sternite* (s 9) is rounded, weakly sclerotized at both ends, and notched laterally just beyond its middle.

According to Pruthi, 1924a, the *median lobe* (ml) together with its *dorsal plate* (k) constitute the *aedeagus* while the *lateral lobes* (ll) are homologous with the *parameres.* Pruthi's very valuable researches on the larva and pupa of *Tenebrio molitor* L. showed that the median lobe and the lateral lobes developed from an originally single pair of appendages in the region of a genital pocket between the ninth and tenth sternites. The basal piece or *tegmen* (bp) also develops in this region as an evagination of the bottom of the genital pocket during pupation.

The *ejaculatory duct* (j) arose from the fusion of the originally paired median lobes along the entire extent of the aedeagus. The gonopore or *median orifice* (to) of the ejaculatory duct is located ventrally at the caudal end of the median lobe. A strengthening *ring-like sclerite* (f) surrounds the gonopore and a *ventral rod* (r) extends from the cephalic margin of the median orifice along the mid-ventral line about as far cephalad as half the length of the median lobe.

Spiracles (sp) :—The structure of the spiracles really calls for an additional study since they are so intricate and important in the life of this water beetle. Brocher, 1912, made an excellent contribution to this phase of the problem when he reported his anatomical and physiological studies on *Hydrous piceus* L.

The position of the first three spiracles has already been described but for the sake of clarity will be repeated here. The first or *mesothoracic spiracles* (sp 1) are located ventrally in the intersegmental membrane between the pro- and mesothorax, and the opening is closely guarded by feathery prolongations. The second or *metathoracic spiracles* (sp 2) consist of simple, annular peritremes with no guarding structures. Each lies in the membrane just above the mesothoracic katepimeron. The third spiracles are the *first abdominal pair* (sp 3) and they have assumed a dorsal position in the membrane just laterad of the first tergite and behind the postalar bridges (pb). According to the researches of Brocher, 1912, the function of the first pair of spiracles is primarily for inspiration since they are best fitted for filtering the air on account of their guarding prolongations. The second and third pairs, being deprived of all protective structures at their entrances, were considered by Brocher as mostly expiratory. However, *Hydrophilus obtusatus* has short prolongations at the openings of the third spiracles (Fig. 22, sp 3). According to Brocher the rest of the spiracles, not including the seventh and eighth abdominal spiracles (sp 9 and sp 10) to which Brocher does not refer, are both inspiratory and expiratory but probably are rarely inspiratory on account of their less developed prolongations.

The spiracles of the *second to sixth abdominal* segments (sp 4–sp 8, inclusive) are dorsal and lie in the pleural membrane (plm) on each side of the second to sixth tergites inclusive. They diminish slightly in size caudad and are rounder than the first three spiracles. The *seventh abdominal spiracles* (sp 9) are very small and almost impossible to find as are the *eighth* (sp 10) which are merely sclerotized tubercles. The former are just laterad of the seventh tergite while the latter are at the sides of the intersegmental membrane between the seventh and

eighth abdominal segments (Fig. 35, sp 10). It is probable that these last two pairs of spiracles are non-functional.

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ABBREVIATIONS ON PLATES

A Anal vein
a anal cross vein
aa anterior arm
ab abductor
ac acetabulum
ad adductor
ae elytral apophysis
aer anepimeron
aet anepisternum
afs antenno-frontal suture
ag apodeme
al jugalula (alula)
an anus
anp anterior notal process (suralare)
ant antenna
ap anterior piece
as antero-lateral series
axc axillary cord

b body of tentorium (corpotentorium)

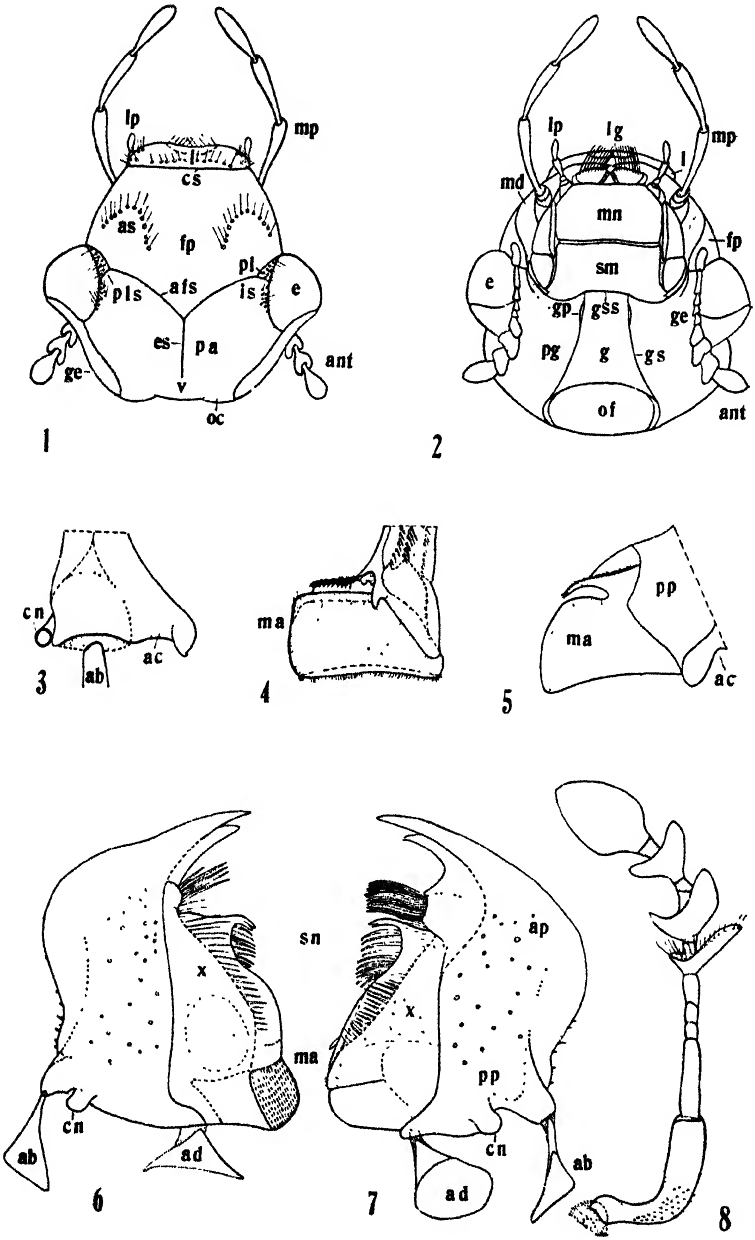
ba	basisternum
be	basanal ossicle (basanale)
bg	basigalea
bp	basal piece (tegmen)
bs	basistipes
C	Costa
c	coxite
ca	cardo
cc	coxal cavity
ce	neck (cervix)
cf	pleural coxal process (coxifer)
cl	claw (unguis)
cm	connecting membrane
cn	condyle
cp	coxal process
cs	clypeal suture
Cu	Cubitus
cu–a	cubito-anal cross vein
cx	coxa
d	dorsal arm
dg	distigalea
di	digitus
e	compound eye
ed	endodorsum
ei	epipleuron
em	elytral margin of jugalula
ep	epipharynx
es	epicranial suture
f	ring-like sclerite
fe	femur
fp	fronto-postclypeus
fs	furcasternum
ft	furcal arm
fu	furcal pit
g	gula
ge	gena
gp	gular pit
gs	gular suture
gss	gulo-submental suture
h	cephalo-ventral arm (tergite 9)
i	axillary sclerite
in	subnotal suture
ip	lateral cervical plate (lateral cervicale)
is	interocular series
j	ejaculatory duct
k	dorsal plate of median lobe
ker	katepimeron
ket	katepisternum
ks	internal shelf
l	labrum
la	lacinia
lg	ligula
ll	lateral lobe
lm	anterior or lateral margin
lp	labial palpus
M	media
ma	molar area
m–cu	medio-cubital cross vein
md	mandible
me	metanotal groove (median)
mek	metasternal keel
mg	glossa
ml	median lobe
mn	mentum
mo	second axillary sclerite (median ossicle)
mp	maxillary palpus
ms	medistipes
msk	mesosternal keel
mts	metasternal spine
mu	muscle disc
n	precoxal fold or suture
nm	notal margin of jugalula
nt	1st axillary sclerite (notale)
oc	occiput
od	occipital condyle (odontoid process)
of	occipital foramen
p	pleurite

pa	parietal sclerite
pb	postalar bride (postalare)
pc	precoxal bridge (antecoxale)
pe	prepectus
pf	palpifer
pg	postgena
ph	prephragma
pi	posterior or sutural margin
pl	parocular sclerite
plg	palpiger
plm	pleural membrane
pls	parocular suture
pm	prementum
pn	pseudopleuron
pnp	posterior notal process (adanale)
po	posterior arm
pp	posterior piece
pph	postphragma
pr	paraglossa
prs	parascutellum
prt	prealar bridge (prealare)
ps	parastipes
psc	prescutum
psl	postscutellum
pt	pretarsal process
px	postcoxal bridge (postcoxale)
R	Radius
r	ventral rod
r–m	radio-medial cross vein
R_s	stem of radial sector
rt	remnant of first abdominal tergite
s	sternite
Sc	Subcosta
sc	scutum

sh	pronotal shelf
si	scutal incision
sl	scutellum
slm	scutellar margin
sm	submentum
sn	spiniferous margin
sp	spiracle
sr	scutellar ridge
ss	surstylus
st	stylus
su	pleural suture
sul	subalar plate (subalare)
t	tergite
ta	tarsus
te	tendon
tc	trochantral cavity
ti	tibia
tis	tibial spur
tn	trochantin
to	median orifice (gonopore)
tr	trochanter
v	vertex
vf	"valvifer"
vn	articulating notch of "valvifer"
vp	ventral grooved plate
vr	eversion rod
w	wedge cell
wp	wing process
x	corrugated area
y	precervicale
z	postcervicale

PLATE VII

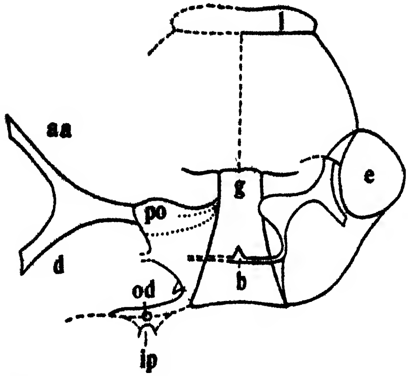
Figure 1. Head, dorsal view.
Figure 2. Head, ventral view.
Figure 3. Left mandible, lateral view of proximal portion.
Figure 4. Left mandible, mesal view of proximal portion.
Figure 5. Right mandible, dorsal view of proximal portion.
Figure 6. Right mandible, ventral view.
Figure 7. Left mandible, ventral view.
Figure 8. Right antenna, ventral view.



HYDROPHILUS OBTUSATUS

PLATE VIII

Figure 9. Endoskeleton of the head from above.
Figure 10. Labrum and epipharynx, ventral view.
Figure 11. Right maxilla, dorsal view of distal portion.
Figure 12. Right maxilla, ventral view.
Figure 13. Labium, ventral view.



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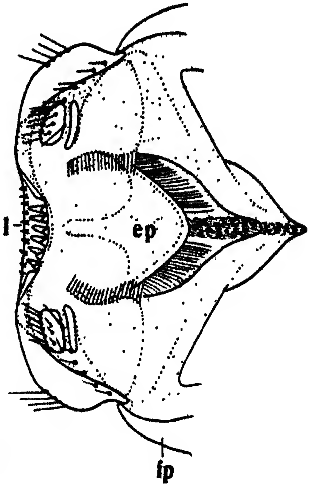

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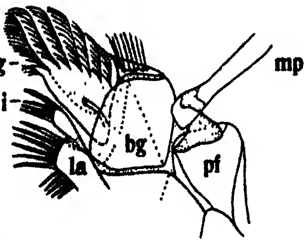

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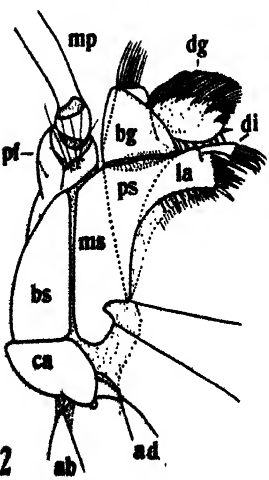

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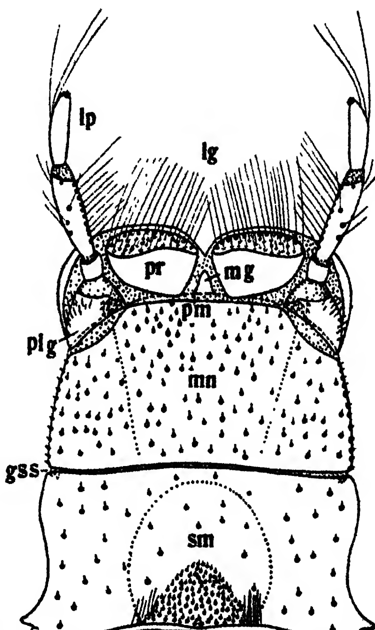

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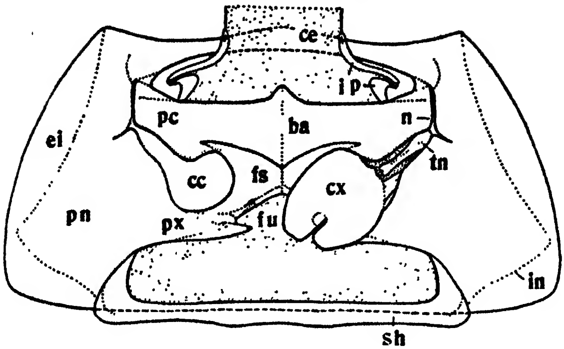
PLATE IX

Figure 14. Prothorax, ventral view.
Figure 15. Coxal process, ventro-mesal view.
Figure 16. Coxal process and trochantin, dorso-lateral view.
Figure 17. Right prothoracic trochanter, in situ, ventral view.
Figure 18. Right prothoracic leg, caudal view, female.
Figure 19. Right prothoracic claw, caudal view, male.
Figure 20. Lateral cervical plates, lateral view.



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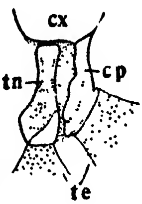

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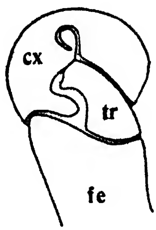

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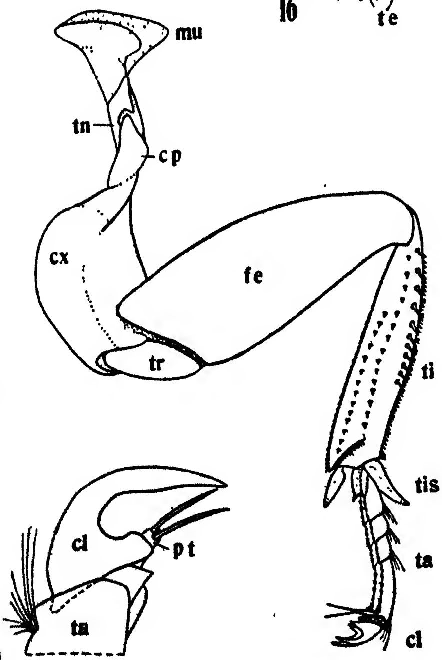

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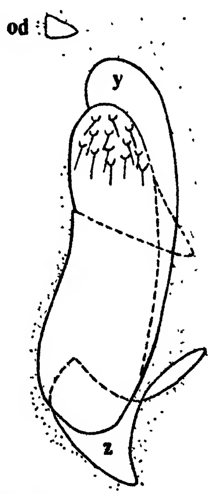

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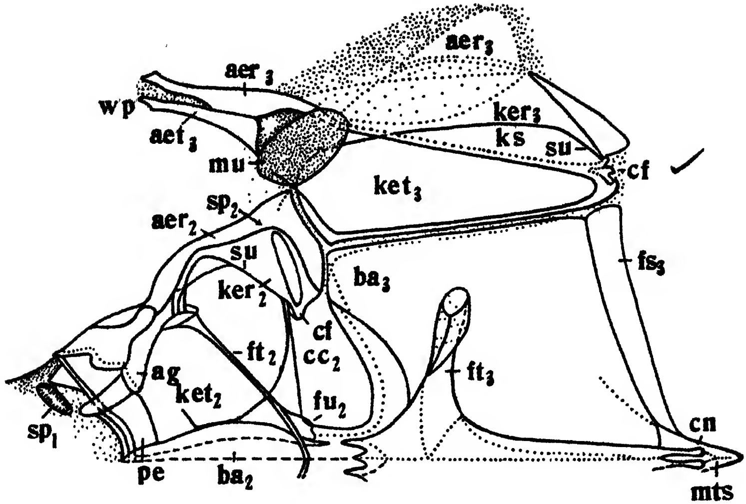
PLATE X

Figure 21. Internal view of sternum and pleuron of the meso- and meta-thorax, together with furcal processes. Right side only.

Figure 22. External view of same sclerites as shown in figure 21.



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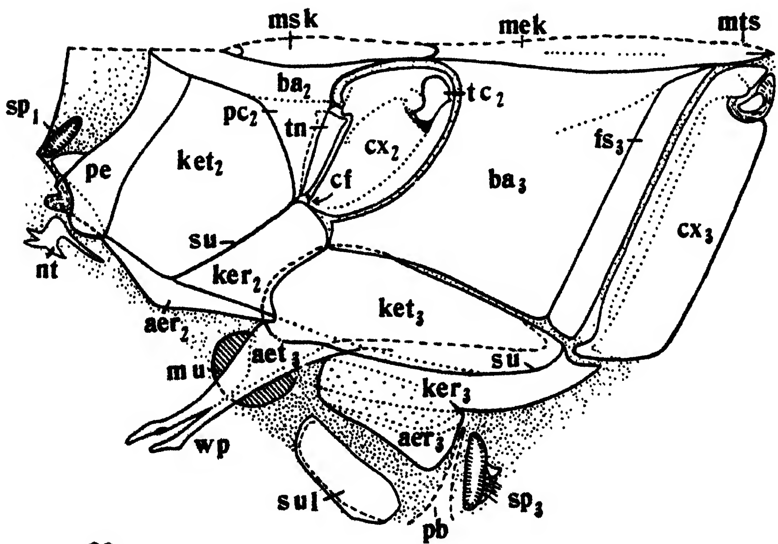

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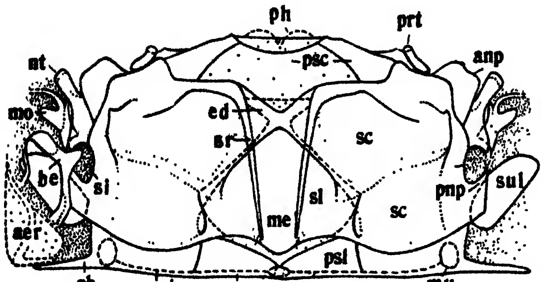
PLATE XI

Figure 23. Metathorax, dorsal view.
Figure 24. Left jugalula, dorsal view.
Figure 25. Mesothorax, dorsal view.
Figure 26. Left elytron, ventral view.
Figure 27. Left elytron, dorsal view.
Figure 28. Right wing, dorsal view.



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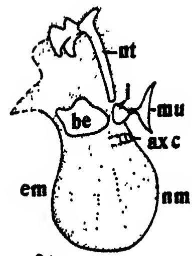

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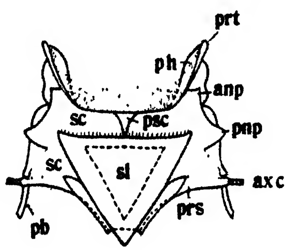

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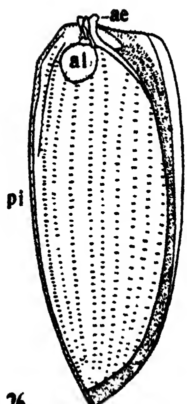

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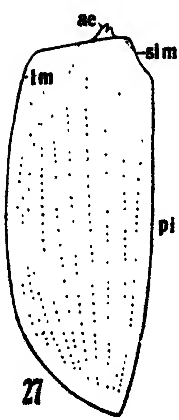

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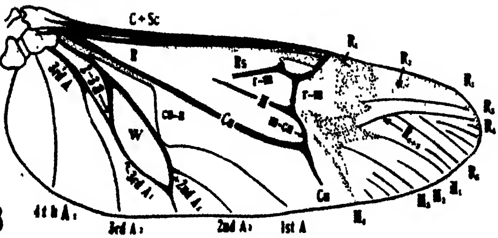

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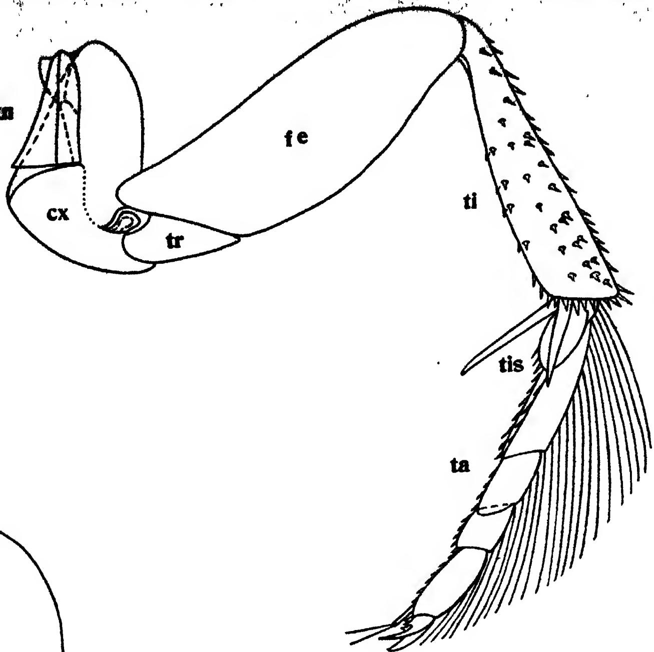
PLATE XII

Figure 29. Left mesothoracic leg, cephalic view, female.
Figure 30. Left metathoracic leg, cephalic view, female.



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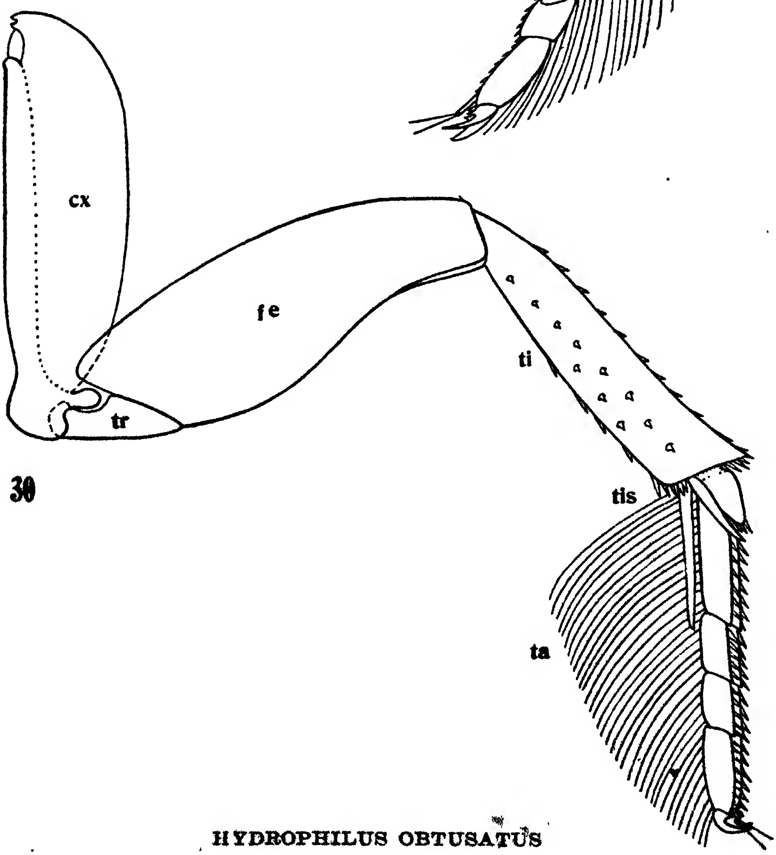

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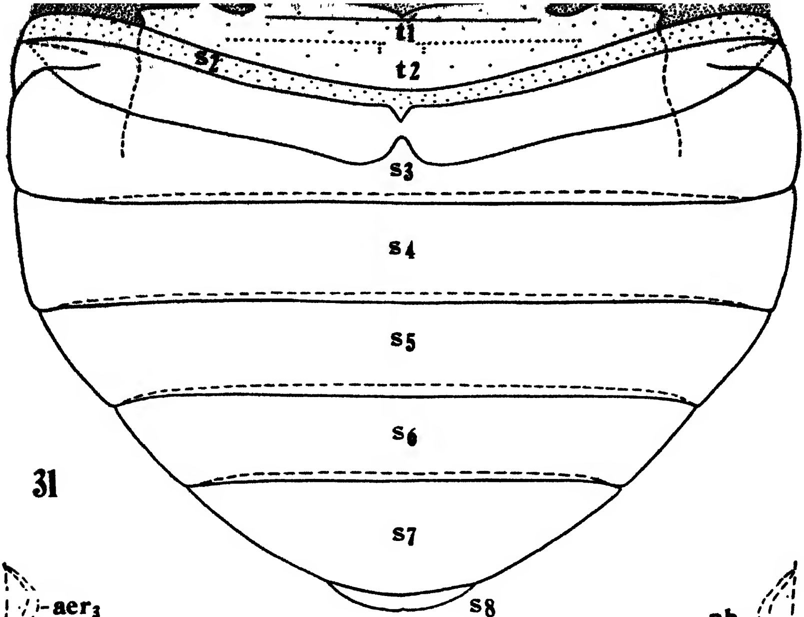
PLATE XIII

Figure 31. Abdomen, ventral view, female.
Figure 32. Abdomen, dorsal view, female.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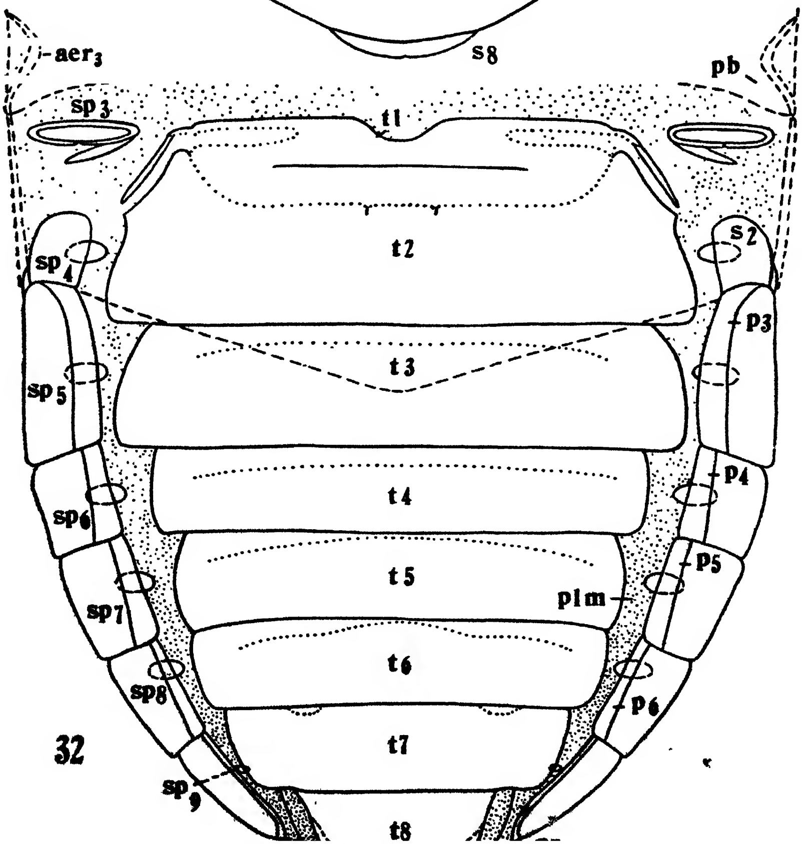
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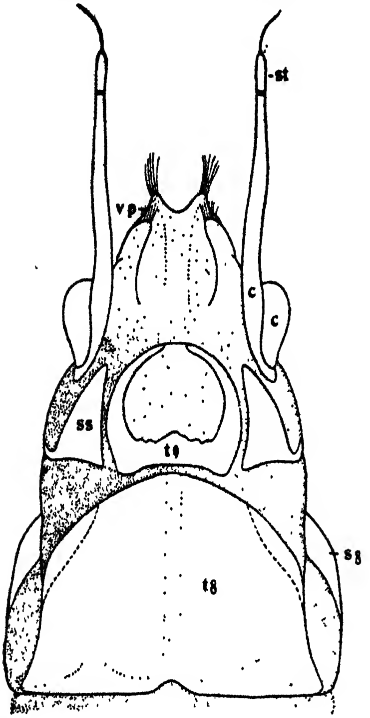
PALTE XIV

Figure 33. Terminal abdominal segment, dorsal view, female.
Figure 34. Terminal abdominal segment, ventral view, female.
Figure 35. Terminal abdominal segment, lateral view, female.



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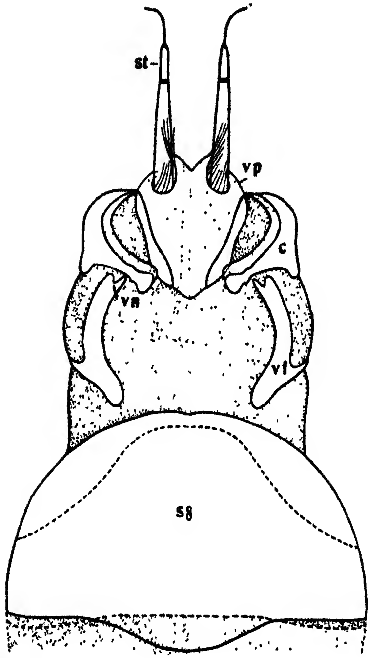

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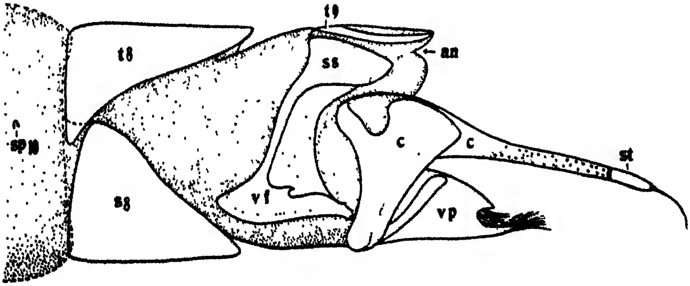

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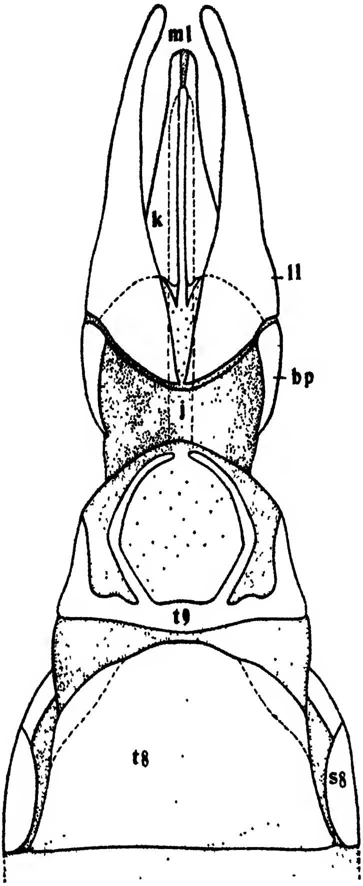
PLATE XV

Figure 36. Terminal abdominal segment, dorsal view, male.
Figure 37. Terminal abdominal segment, ventral view, male.
Figure 38. Ninth abdominal sternite and adjacent sclerites, ventral view, male.



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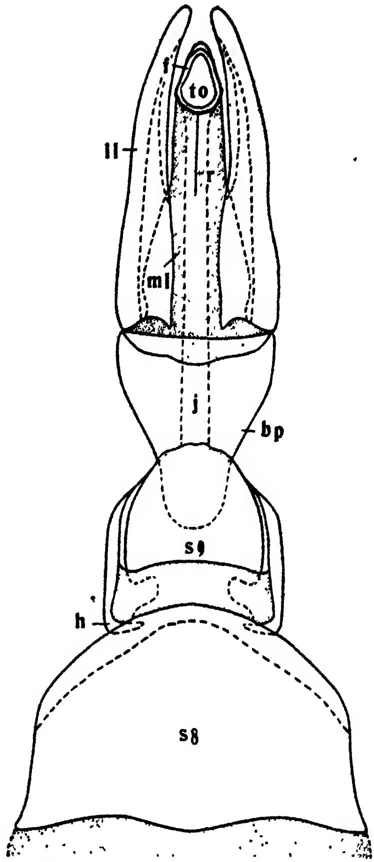

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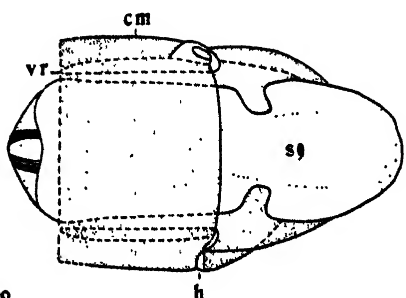

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JOHN SOUTHALL'S "TREATISE OF BUGGS"

BY HARRY B. WEISS
NEW BRUNSWICK, N. J.

I have not decided definitely whether Mr. John Southall was a commercial entomologist or a clever writer of advertisements. Nor does it matter greatly, because he really embodied the characteristics of both. And because it is difficult to find traces of either commercial entomologists or clever copy writers after a lapse of two hundred years it is necessary to state with regret that details of the personal life of John Southall are absent from this account. However, he lived in London, when "True Friars Balsam," "Comforting Stomack Plaisters," "Lisbon Snuff," "Styptic Water," "Headache Essence" and "Elixir of Balme and Mint" were sold and when "Crazy Sally" Mapps, enormously fat and ugly, was practicing her profession of bone-setting with extraordinary success and performing her cures before Sir Hans Sloane at the Grecian Coffeehouse.

Mr. Southall's thin volume of xii + 44 pp., entitled "A Treatise of Buggs," was published in London in 1730 and from the title page one learns that he was the "Maker of the Nonpareil Liquor for destroying *Buggs* and *Nits*" and that he lived at "the *Green Posts* in the *Green Walk* near *Faulcon-stairs, Southwark.*" It is stated also that his "Treatise" was "Printed for J. Roberts, near the *Oxford-Arms* in *Warwick-Lane*" and it seems safe to assume that this is the same James Roberts who acted on numerous occasions as the acknowledged partner of Edmund Curll, the London publisher who provided scandal and obscenity, who stole titles from rival publishers, who published old books as if they were new, who announced new editions of books that had never been printed before, who invented authors, who pirated the works of Prior, Swift, Gay, Addison and Pope, and who stood in the pillory at Charing Cross for an hour on February 23, 1728.

Southall dedicated his "Treatise" to Sir Hans Sloane, "First Physician in Ordinary to His Majesty; President of the Royal

Society, and also of the College of Physicians'' and in the dedication he speaks of the "ready Condescension'' of Sir Hans Sloane to peruse his treatise and to view the experiments with his "Liquor'' both in its "bringing out, and destroying Buggs; as also that of its no ways staining Furniture.'' Sloane apparently approved the "treatise,'' introduced it to the Royal Society and supervised the making of the copperplate which accompanied it, for all of which Southall expressed his thanks in print. If it seems strange to some that Sir Hans Sloane at one time gave public approval to a bed-bug remedy, it should be remembered that some men of eminence have always been willing to endorse something—for a consideration. It is stated that Sir Hans Sloane sold an eye salve and that his name was associated with a "milk chocolate.''

Southall begins his little book by saying that bed-bugs were known to be in England more than sixty years and that they were increasing so rapidly as to become terrible to almost every person in and near London. And since his return from America he has made their destruction his profession, not alone with a view toward private gain but for the public good as well. In this he was encouraged by "The late Learned and truly Valuable Dr. *Woodward*,'' the same Dr. John Woodward who in 1710 had insulted Sir Hans Sloane at a council meeting of the Royal Society, and refusing to apologize, had been expelled from the council. Later he brought suit, but lost. Woodward was at one time professor of physic in Gresham College. His "State of Physic'' published in 1718 attacked the work of Dr. John Freind and as a result there arose a violent dispute, during the course of which Woodward was attacked by Dr. Richard Mead one evening in June, 1719. Swords were drawn and Woodward was saved only by the intervention of onlookers.

In 1726 Southall went to the West Indies on business and while there he became sick and not only lost the use of his limbs but was given up by the best physicians at Kingstown in Jamaica. Recovering sufficiently to make the trip back to England, he "killed'' time while waiting for the boat by riding around the countryside. During one of these journeys he met an "uncommon negro'' whose hair and beard were as white as

snow and who "moved briskly, had no Wrinkles, and all his Teeth." To this negro, Southall gave a little tobacco and while they were talking, the negro observing that Southall rubbed and scratched his face and eyes which "were much swelled with Bugg-Bites," asked him if he had been bitten by "Chintses." Southall replied, "yes," and after more conversation, a bargain was made whereby Southall departed with a "Calibash full of Liquor" for killing bed-bugs and left behind some tobacco and a piece of Spanish money, worth about seven and a half cents. Southall used some of the liquid before he went to sleep and the instant he applied it—"vast Numbers did come out of their Holes, and die before his face." And in the morning he found that many more had died.

Resolving to obtain the formula, he again visited the negro and after more preliminaries including talk, the drinking of beer and eating and a final gift of some English Beef, pork, biscuit, beer and tobacco, Southall accompanied the negro to the woods where they gathered materials for the remedy. After returning to the negro's hut, he made a record of the names, quantities and method of making and mixing the composition and after filling the empty beer bottles with the liquor, he returned home, well pleased with himself.

After his arrival in London in August, 1727, he manufactured some of the liquor and used it successfully. He advertised, did a big business and pleased every one. However, although he was able to kill adult bugs, the young ones continued to appear and at that time his liquor was so strong and oily that he dared not apply it to furniture for fear of damaging it. After more experiments he finally developed a satisfactory compound. Having gained this point, he "then went on briskly, and destroy'd Buggs and Nits in all Beds and Furniture." But still, young ones continued to appear and this worried him and because he could find no satisfactory account of the bed-bug in print, he bought microscopes and decided to look into things for himself. As a result of his research he was able to describe the bed-bug as follows:

"A Bugg's Body is shaped and shelled, and the Shell as transparent and finely striped as the most beautiful amphibious

Turtle; has six Legs most exactly shaped, jointed and bristled as the Legs of a Crab. Its Neck and Head much resembles a Toad's. On its Head are three Horns picqued and bristled; and at the end of their Nose they have a Sting sharper and much smaller than a Bee's. The Use of their Horns is in Fight to assail their Enemies, or defend themselves. With the Sting they penetrate and wound our Skins, and then (tho' the Wound is so small as to be almost imperceptible) they thence by Suction extract their most delicious Food, our Blood. This Sucking the Wound so given, is what we improperly call biting us."

In addition, he was able to distinguish the sexes and he placed pairs of them in vials together with various foods and finally secured eggs. He describes the eggs and the colors of the bugs at various stages of their growth.

"Buggs of one day old, are white as Milk.

"At three days old, are Creame-colour'd,"

and so on, ending with—

"At seven Weeks, they come to be of their own proper Colour, all over brown.

"At eight Weeks, they grow bigger.

"Nine Weeks, Ditto.

"Ten Weeks, Ditto.

"At eleven Weeks, they are full grown."

He found their "beloved Foods" to be "Blood, dry'd Paste, Size, Deal, Beach, Osier, and some other Woods, the Sap of which they suck; and on any one of these will they live the Year round." When he placed pairs of bugs on oak, walnut, cedar and mahogany, they starved to death. He further found that as a rule, fifty eggs were deposited at one time, in March, May, July and September, and that, for every pair that lived out the season, about 200 eggs were produced. In heated rooms during the winter, however, breeding went on and they were "brisk and stout" under such conditions.

Southall concluded that the winter was the best season during which to kill bugs. He demonstrated his remedy before Sloane on December 30, 1729, and after applying his liquor with a feather, the vermin bolted out of their holes and as usual, died "before his face." As a result of his observations and study,

the mystery of young bugs continuing to appear, after applications of his remedy, was solved. Although his liquor brought out and destroyed every live bug, "yet their Nits being inanimate, cannot come to the Liquor, nor the Liquor at them."

The remainder of the treatise is given over to a discourse on bug bites, the locations of eggs and the introduction of bugs into England on trading ships and the consequent infestations of seaports. People are warned to examine the baggage of new servants—and—"let no Washer-woman's Basket be brought into your Houses." Builders are also blamed for using old infested wood in new houses.

Southall then gives directions for applying his Nonpareil liquor to furniture, velvets, silks, etc. A bottle costing two shillings was enough for a common bed. If one did not care to do the work Southall or his servants would do it, taking down the beds, if necessary, and putting them up again. For such services his terms were as follows:

"To clear a Bed-sted with Moulding-Tester, Wood Head-Cloth, Headboard and its Furniture, 10s. 6d.

"Bed-steds with single-rais'd Tester, Moulding, Head-Cloth, Board and Furniture, or Chair-beds and Furniture, 8s. each.

"Bed-steds with ditto Tester, plain Head-cloth, cover'd Headboard and Furniture; and Field-beds and Furniture, at 7s. each.

"Four-post Bed-steds, or Canopy-beds, with plain Furniture, 6s. each.

"Press-beds, Chest of Drawers Beds and Bed-steds, without Furniture, 5s. each.

"Wainscot Walls, Hangings, &c. behind and near the Bed-sted are clear'd with the Beds at the above Prices: but if spread all over the Room and Furniture, then an additional Price is expected."

Without attempting to correct Southall's misinformation about the bed-bug, it is of interest to state that Moffett in his "Theater of Insects" first published in London in 1634, states that, "In the year 1503 [?] Dr. Penny was called in great haste to a little village called Mortlake, near the Thames, to visit two noble ladies, who were much frightened by the appearance of bug-bites (*ex cimicum vestigiis*), and were in fear of I know not

what contagion; but when the matter was known, and the insects caught, he laughed them out of all fear." Cowan believed that Moffett's statement disproved the idea advanced by Southall that the bed-bug was not known in England before 1670 and also the idea of Linnaeus and other later writers who thought that it had been introduced into England after the great fire of London in 1666, in timber from America.

Although Southall's interesting pamphlet appears to be a treatise on insects, it is really a clever advertisement.

A TREATISE OF BUGGS:

SHEWING

When and How they were firſt brought into *England*. How they are brought into and infect Houſes.

Their Nature, ſeveral Foods, Times and Manner of Spawning and Propagating in this Climate.

Their great INCREASE accounted for, by Proof of the Numbers each Pair produce in a Seaſon.

REASONS given why all Attempts hitherto made for their Deſtruction have proved ineffectual.

VULGAR ERRORS concerning them refuted.

That from *September* to *March* is the beſt Seaſon for their total Deſtruction, demonſtrated by Reaſon, and proved by Facts.

Concluding with

DIRECTIONS for ſuch as have them not already, how to avoid them; and for thoſe that have them, how to deſtroy them.

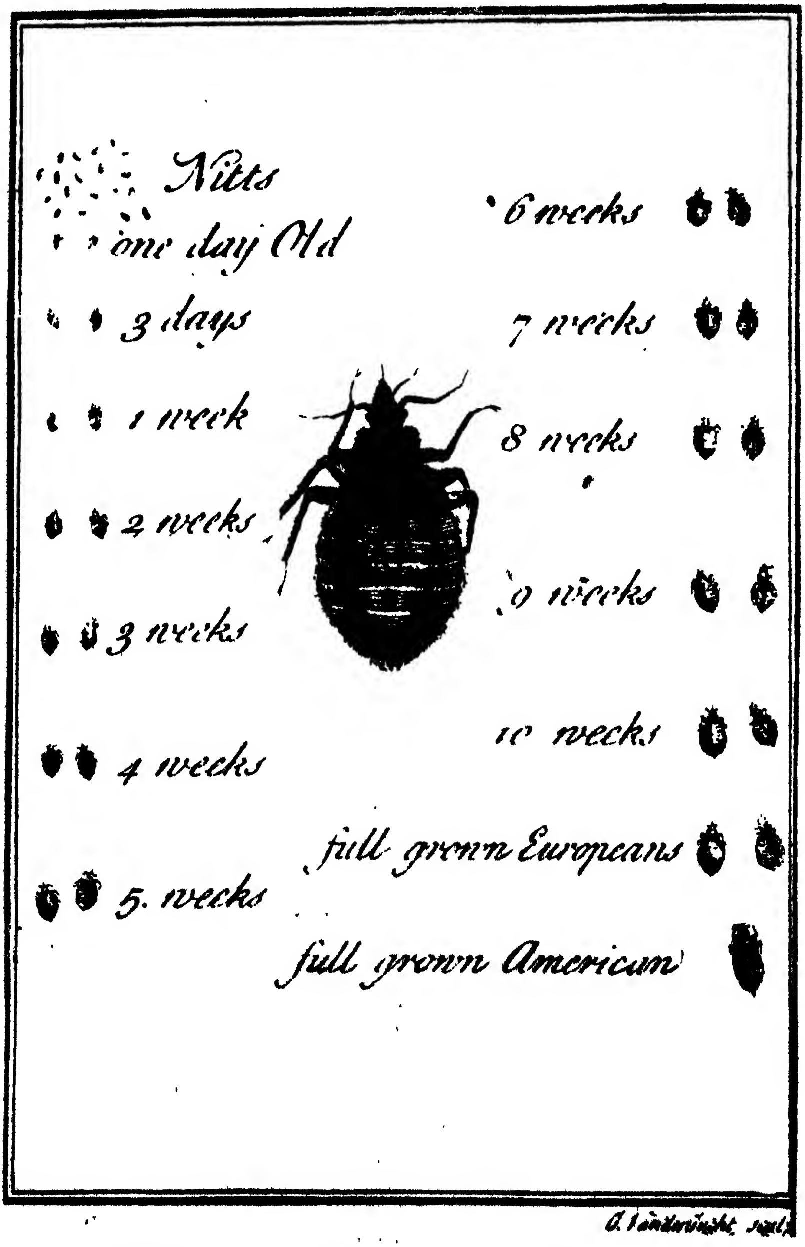
By *JOHN SOUTHALL*,

Maker of the Nonpareil Liquor for deſtroying *Buggs* and *Nits*, living at the *Green Poſts* in the *Green Walk* near *Faulcon-ſtairs*, *Southwark*.

LONDON. Printed for J. ROBERTS, near the *Oxford-Arms* in *Warwick-Lane*. M.DCC XXX.

(Price One Shilling.)

TITLE PAGE OF SOUTHALL'S "TREATISE OF BUGGS"



FRONTISPIECE OF SOUTHALL'S "TREATISE OF BUGGS"

BOOK NOTICE

A manual of the genera of beetles of America, north of Mexico; keys for the determination of the families, subfamilies, tribes and genera of Coleoptera with a systematic list of the genera and higher groups, by J. Chester Bradley. Dow Illston & Co., Ithaca, N. Y. Pp. x + 360. 1930. Lithoprinted—(Boards, $5; Cloth, $6).

A year or so ago one of our leading coleopterists lamented to the reviewer that if he could only be relieved of his other professional duties for the next decade he might be able to produce a new work on the genera of Nearctic Coleoptera. While the coleopterists have lamented, an entomologist has acted! For the third time in the history of the study of the Nearctic Coleoptera a monumental work has been achieved by one not primarily a student of beetles.*

Bradley's *Genera of Beetles* brings up to date the keys contained in LeConte and Horn's *Classification* (1883). It provides a book to which, in conjunction with an introductory textbook of entomology and Leng's *Catalogue*, the beginner in coleopterology can go. It is, on the other hand, a work indispensible to the advanced student who would keep abreast of the latest developments in his field.

Professor Bradley has made every attempt to make his work present the most modern aspects of his subject. Founded in general on Leng's *Catalogue* (1920), he has not hesitated, for instance, to present Sloan's (1923) entirely different sequence of tribes of Carabidæ, to adopt a separate suborder (Archostemata) for the Micromalthidæ and Cupedidæ, or to unite the Galerucinæ and Halticinæ in a single subfamily. On the other hand, he retains such peculiarities of Leng's system as the families Omophronidæ and Trogidæ and the abolition of the Heteromera.

The keys are complete with the exception of occasional genera mentioned in a foot-note. An important exception should, how-

* I refer, of course, to Henshaw's *List*, and Blatchley's *Coleoptera of Indiana*.

ever, be noted in the keys to the tribes Bolitocharini, Zyrini, and Aleocharini of the Aleocharinæ in which only 7, 22, and 12 genera are considered out of totals of 24, 48, and 34 genera respectively. This, of course, is due to our fragmentary knowledge of these groups.

One might wish that Professor Bradley had given more attention to subgenera, but to have done so probably would have unduly extended the book. The writer feels that subgenera serve the admirable purpose of enabling one to remain conservative regarding the acceptance of genera without giving the appearance of "lumping." In several cases in the Carabidæ parallel keys to genera have been given, one for Casey's genera, the other for a more conservative system. In this connection Casey's segregates of *Amara* have been omitted when they are, in reality, no less valid than his segregates of *Pterostichus*, *Platynus*, *Anisodactylus*, etc.

The reviewer notes with interest that, whereas, Professor Bradley has not accepted his thesis that the Silphinæ constitute a subfamily of Staphylinidæ, the adequate separation of these groups has received usually careful attention. It is unfortunate for the relatively highly specialized Leiodidæ to precede the Silphinæ and Staphylinidæ in the Staphylinoid series.

It would have been helpful if complete bibliographical references had been given for those citations not included in the bibliography of Leng's *Catalogue* or its *Supplement*.

The following recent changes in the names of genera may be noted: *Omaseus* (p. 30) = *Melanius* Bon; *Micromaseus* (p. 30) = *Americomaseus* Csiki; *Casnonia* (p. 39 = *Colliuris* subg. *Odacanthella* Liebke; *Brachypterolus* (p. 146) = *Anthribus* Geoff. There are three American species of *Amphizoa* (p. 43), not two.

Finally, the reviewer would like to see the present work followed by a handbook of our entire Coleopterous fauna executed along the lines of, for instance, Porta's *Fauna Coleopterorum Italica*. The work could be done! Most of the barriers are psychological!—MELVILLE H. HATCH.

PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

MEETING OF MARCH 4, 1930

A regular meeting of the New York Entomological Society was held at 8 P. M., on March 4, 1930, in the American Museum of Natural History; President Wm. T. Davis in the chair with eighteen members and four visitors present.

Mr. Davis exhibited the Annual Report of the Association of the Graduates of the United States Military Academy, published June 12, 1929, and containing an obituary of Col. Wirt Robinson which included a tribute written by Mr. Davis.

He also exhibited and read, in part, a poem written by James G. Needham entitled "Nature Study."

Mr. Bromley read an exhaustive account of "Bee-Killing Robberflies" which will be printed in full. He reviewed the early work of Asa Fitch and C. V. Riley, and the subsequent literature, and then passed to a detailed account of the species in connection with killing habits, if any, leading to the conclusion that *Promachus fitchii* was the most likely to become of economic importance, with some species of *Mallophora* less likely. Mr. Bromley closed his remarks with lantern slide illustrations of several species showing their method of attack.

In the discussion which followed in which Mr. Schwarz, Dr. Felt and Mr. Davis took part, it was disclosed that *Promachus fitchii,* abundant in fields where its larvæ feed on white grubs, might destroy 140 honey bees in a day and thus be harmful to near-by apiaries. Dr. Felt spoke of the pain inflicted by robberflies, being like the jab of a needle, and Mr. Davis described the large, sharp spines on the hind legs of *Midas.* The latter also spoke of the varied transformations of robberflies, one subfamily using the soil, another always preferring wood.

Mr. Davis exhibited a leaf of redbud which he had found at Great Falls, Md., June 27, 1914, with twenty symmetrical holes around its edge, cut by a species of upholsterer bee, as well as other examples of their work and some of the bees identified many years ago by Dr. Ashmead.

Mr. Schwarz exhibited a contribution to the Ecology of Melipomene Bees by Dr. George Salt.

MEETING OF MARCH 18, 1930

A regular meeting of the New York Entomological Society was held at 8 P. M. on March 18, 1930, in the American Museum of Natural History; President Wm. T. Davis in the chair with eighteen members and nine visitors present.

The president exhibited with praise Dr. Kinsey's work on "Gall Midges of the genus *Cynips*." Dr. Lutz joined in its praise as did Dr. Felt, who spoke of the extensive material studied, amounting to 37,000 wasps and 50,000 galls, and of the connection of alternate generations being still comparatively unknown.

Mr. Bird under the title "A Lepidopterous Anomaly—The Emergence of Many Moths from a Single Cocoon" told an entertaining story of one of his best records, which will be printed in full. The cocoon was that of a *Luna* moth; the seventeen tineid moths which emerged had their pupa shells hooked on to the cocoon. In the discussion that followed, in which Messrs. Davis, Angell, Lemmer and Dr. Felt took part, the habits of tineid moths were mentioned and the theory of polyembryonic emergence was explained by Mr. Bird with special reference to his own experience in rearing 1,732 parasites from one *Plusia* caterpillar.

Dr. Lutz spoke briefly of the reproduction for the sound movies of the cricket's shrill tones, describing the capture of the crickets, the cages made from lantern globes, in which they were kept and the process of recording their stridulations. The remarkable corollary, which came from his subsequent study of the film produced, showed that what sounds like a single note is in reality three pulses.

Mr. Davis exhibited a ♂ *Panchlora*, a green cockroach, which had matured in captivity about March 12, and read a paper on ovoviviparity in roaches which will be printed in full. He also mentioned several instances of butterflies being attacked by crab-spiders, viz.: August 13, 1905, at Tottenville—*Papilio troilus* found dead roadside, a small crab-spider attached; September 5, 1911, at Yaphank—*Pyrameis huntera* found dead in the same way; July 21, 1929, at Stamford, Conn.—*Chrysophanus hypophlaeus* seen on *Rudbeckia*, from which it flew with the crab spider attached. On the same visit to Stamford the bean beetle was seen and studied.

Mr. Bromley spoke of the abundance of *Paratenodera sinensis* in New Jersey, Pennsylvania, and Staten Island, and of the introduction of Staten Island eggs at Stamford.

Dr. Lutz added that Hartford was another point in Connecticut where the insect has been introduced.

Mr. Lemmer exhibited the moth *Zale lunata*, which hibernated, and *Zale mineria* which does not.

MEETING OF APRIL 1, 1930

A regular meeting of the New York Entomological Society was held at 8 P. M., on April 1, 1930, in the American Museum of Natural History; President Wm. T. Davis in the chair with twenty members and six visitors present.

Dr. Felt read a considerable number of verses relating to insects, quoting from more than fifty authors and closing with a selection from Dr. Holland's Moth Book, written in prose but embodying poetical ideas.

The subject interested many of the members, Dr. Lutz, Messrs. Angell, Davis, Curran, Bromley and others contributing verses which lived in their memories.

Mr. Mutchler spoke of the Palm Weevil, and Mr. Davis added from his Floridian experiences the delicate meal which its larvæ afford raccoons.

Mr. Bromley proposed for membership: Mr. Cecil W. Coates, 508 Produce Exchange, New York City.

MEETING OF APRIL 15, 1930

A regular meeting of the New York Entomological Society was held at 8 P. M. on April 15, 1930, in the American Museum of Natural History; President Wm. T. Davis in the chair with twenty-one members and twelve visitors present.

The following members were elected:

Mr. Cecil W. Coates, 508 Produce Exchange, New York City.

Mr. E. G. Smyth, Hacienda Cartavio, Saleverry, Peru.

The following publications were exhibited:

Proceedings Fourth International Congress of Entomology, with group photograph.

List of the Cicindelidæ of America, North of Mexico, by Dr. W. Horn.

Index to Publications of the Department of Agriculture.

Proceedings of the Staten Island Institute of Arts and Sciences.

Dr. William Moore spoke of "Reactions of Clothes Moth Larvæ" with lantern slide illustrations. His remarks, which related principally to the webbing clothes moth, covered a series of experiments to determine the value of various methods of combating this pest. It was shown that the moth prefers to work in darkness, and that all the usual repellents were of some value, cinchona alkaloids especially. Applications designed to poison the larvæ were also considered.

In the discussion following Dr. Moore's address, in which Messrs. Davis, Safro, Bromley, Huntington and Dr. Britton participated, the value of sunlight, cleanliness, cedar chests, and cold storage, the latter producing principally a state of quiescence, were considered.

Mr. Wurster exhibited an extraordinary specimen of *Polyphemus*, hatched from one of about 600 cocoons received from the vicinity of Chicago, melanism producing an almost entirely black moth.

MEETING OF MAY 6, 1930

A regular meeting of the New York Entomological Society was held at 8 P. M., on May 6, 1930, in the American Museum of Natural History; President Wm. T. Davis in the chair with twenty-six members and thirteen visitors present.

The death of Dr. Morton R. Peck on March 11, and of Dr. Wm. Barnes on May 1, 1930, was announced.

Letters from John D. Sherman, Jr., from Egypt, to Mr. Davis and from Italy to Mr. Leng were read.

J. D. Gunder's account of the Department of Lepidoptera in the American Museum of Natural History was shown.

Mr. Frank Morton Jones made an address on "Collecting in the Southern Everglades: the Sleeping Heliconias" illustrated by lantern slides, photographs, and specimens of the insects he collected. From headquarters at the Lodge on Royal Palm Hammock Mr. Jones explored in 1929 and again in 1930 a number of the hammocks in the Everglades which since 1883 have become gradually accessible, and which yield a considerable number of subtropical insects. After a general description of this interesting locality, its fauna and flora, and references to Theodore L. Mead, still living in Florida, Dr. W. S. Blatchley, who has made important studies of the Coleoptera, the Grossbeck-Watson list of Lepidoptera, and the assistance of Warden Wheelock, Mr. Jones proceeded with a detailed account of his observations of the early morning flight of *Tabanus americanus* ♂, and of the sleeping habits of *Heliconia* butterflies. These observations will be printed in full.

In the discussion which followed Mr. Huntington described similar butterfly habits in Trinidad, and Mr. Engelhardt those he had observed in Panama, Guatemala and British Honduras. Mr. Curran also told of a "Morpho Lodge" at Barro Colorado where four, five or even seven of those large butterflies were repeatedly seen.

In regard to the hovering habits of *Tabanus*, Mr. Davis and Mr. Bromley made some comments, the latter stating that the morning serenade by the males was known only in Southern Florida.

Mr. Davis exhibited a cicada of the genus *Plantilla*, showing a concave abdomen, decked over by a transparent membrane, which had been collected by W. Judson Coxie in Ecuador, and received through Dr. Goodwin.

Mr. Wurster exhibited a photograph of the melanistic *Polyphemus* he had shown at preceding meeting.

Mr. Angell spoke of collecting *Ceruchus piceus* at Vermont.

MEETING OF MAY 20, 1930

A regular meeting of the New York Entomological Society was held at 8 P. M., on May 20, 1930, in the American Museum of Natural History; President Wm. T. Davis in the chair with fourteen members and four visitors present.

The President called for spring collecting experiences.

Mr. De Ghika exhibited caterpillars obtained from breeding a male *Erannis tiliaria* from Rye, New York, with a female *Hyberna defoliaria* from Hamburg, Germany, the result being possibly similar to melanistic forms of these geometers.

In the discussion of this matter Mr. Davis showed a specimen of *Ectropis crepuscularia* abberration *fumateria* Minot (defessaria Frey), and Mr. De

Ghika told of the curious outcome of an experiment which produced an equal number of albinistic and melanistic forms.

Mr. Huntington and others spoke of the poor luck at Greenwood Lake and Jamesburg though *Anthocaris genutia* was found at the former locality.

Mr. Nicolay spoke with more enthusiasm of his trip with Mr. Quirsfeld to Piermont, N. Y., where *Oodes, Chlaenius*, and other Carabidæ were found as well as *Cicindela limbalis*. In connection with the latter species Mr. Nicolay expressed some dissatisfaction with the recently published Check List by Dr. Walther Horn.

Mr. Curran exhibited Dr. Shiraki's recent work on the Syrphidæ of Japan, in which 302 species are treated. In connection with Mr. Curran's work on the Syrphidæ of the Malay States, a fairly complete view of the fauna of the Far East is now attainable.

Mr. Wm. T. Davis exhibited many golden rod galls of the moth *Gnorimoschema gallæ-solidaginis* Riley that he had found in the Fort Wadsworth Reservation on Staten Island. The galls were very common over a small area and nearly all of them had been opened presumably by mice. As the galls were opened near the bottom the mouse had in some instances apparently failed to observe that the moth had already escaped from the hole near the top and so found but an empty pupa case; a less substantial meal.

He also showed many other galls, cocoons, acorns, etc., that had been opened by squirrels, mice and woodpeckers, in quest of the fat grubs to be found within.

The remarks of Mr. Davis were discussed by Messrs. Wurster, De Ghika, Huntington, Watson and Bird, the latter stating that mice preferred a pupal diet, requiring a close attention to dates on their part.

Mr. Mutchler spoke of Mr. Wunder's success in rearing Mantis on Fruit fly.

MEETING OF OCTOBER 7, 1930

A regular meeting of the New York Entomological Society was held at 8 P. M., on October 7, 1930, in the American Museum of Natural History; President Wm. T. Davis in the chair with nineteen members and thirteen visitors present.

The President reported the death of Mrs. Anna Botsford Comstock on August 24, 76 years of age, and his sending of a telegram in the name of the Society to Dr. Comstock, which action was approved.

The president also called attention to locality labels printed by A. C. Davis in California.

The secretary spoke of letters from Mr. Sherman, traveling with his family in Egypt and Europe, and to a cartoon by Herbert Johnson in the Saturday Evening Post of September 13, 1930, exhibiting *Paratenedera sinensis* as the Market Bug.

Mr. Charles Louis Pollard exhibited a box of Lepidoptera and spoke of the "Habits of Equatorial Butterflies" as observed by him during his

recent sojourn in Para and Iquitos as collector for Mr. Frank Johnson. In the vicinity of Para, where approximately 600 species are to be found, three environments were recognized, 1, cultivated park lands and fields; 2, cleared open forest land, and 3, the forest or jungle in which by far the greater part of the species were to be found. This was explained, as Mr. Pollard thought, partly by the liking the butterflies showed for exudations from the forest trees, partly by the protection afforded by the forest from such enemies as lizards and spiders. Taking up a few of the many species, and making use of the observations of Rev. Miles Moss which extend over 18 years at Para, Mr. Pollard spoke of the *Aristolochia Papilios* with an unpleasant odor and of their enemies devoid of such odor, of the five species of *Morpho* and their rapid flight, and of several other species, with methods of collecting.

His remarks were discussed by Messrs. Davis, Bell, Bromley, Huntington, and by Dr. Lutz, who said that the Morphos were sometimes called "Heliograph Bug" in Panama.

Mr. Frank Johnson exhibited nine specimens of *Morpho æga* from Sta. Catharine in southern Brazil, arranged to show five females, one hermaphrodite and three males, in a progressive series of color.

Mr. Johnson also mentioned a *Papilio ajax* seen in July on the golf course at Rahway, New Jersey.

The president called for summer collecting experiences.

Mr. Watson considered the season poor for many species of butterflies, though *Colias eurytheme* had been common, and *eubele* had been seen at Oakwood Beach, Staten Island.

Mr. Bell, who had spent much of the summer in Nevada where he had obtained some Cicadas for Mr. Davis, reserved his account of the Lepidoptera for a later occasion.

Messrs. Huntington, Curran, Hall, Sheridan, and Moennich made brief reports, the latter pointing out the apparently greater size attained by *Cicindela 6-guttata* in the northern states.

Mr. Nicolay had visited Moosehead Lake, where he found *Cicindela harrisi*, and Washington, D. C., which he found dry.

Mr. Hartzell was continuing his studies of *Cicadula*. It is known that *C. 6-notata* carries the aster yellows. Other species, *C. petoria, lepida,* and *slossoni* were also studied; it is not known whether or not these are disease carriers.

Mr. Hartzell also spoke of *Aserica castanea* grubs as prevalent in lawns; and of the flight of *Mantis*.

Mr. Angell exhibited a box of summer captures, including *Dorcas brevis*, the fourth specimen known. It was found dead in the rock at Lakehurst, New Jersey, on August 18, by Chas. Ballou.

Other species were:

Dorcas parallelus Female, Cooks Falls, New York. In dead maple stump. September 15, 1930. J. W. Angell.

Dorcas parallelus Female, Selkirk Beach, Lake Ontario, New York. In wash-up. July 7, 1930. Chas. Ballou, Jr.

Platycerus quercus (♂ & ♀), Dumont, New Jersey.

Ceruchus piceus (♂ & ♀), Kensico, New York. In dead hemlock. September 21, 1930. J. W. Angell.

Nicagus obscurus (♂ & ♀), Sylvan Beach, Lake Ontario, New York. Flying over vegetation. Chas. Ballou, Jr.

Cicindela ancocisconensis, Cooks Falls, New York. September 15, 1930. J. W. Angell.

Cicindela hirticollis, Sylvan Beach, Lake Ontario, New York. June 2, 1930. Chas. Ballou, Jr.

Necrophorus pustulatus, Lakewood, New Jersey. In flight. July 5, 1930. Alfred J. Kestler.

Dr. Lutz had spent much of the summer in Yellowstone National Park engaged mainly on outdoor educational projects. Opportunities for studying the insects of the hot springs and effluent streams were, however, found. In the course of his visit he had met Dr. Brues and Dr. Van Dyke.

Mr. Mutchler spoke of the work in progress on the beetles of Porto Rico; and of the migration of Monarch butterflies observed in Connecticut by Dr. Sherwood, director of the American Museum of Natural History. While more abundant than in recent years, the number was less than has been previously recorded.

The subject of Monarch migration and the scarcity of the species in some years was discussed by Dr. Lutz, Messrs. Davis, Watson and Bell with a suggestion, based on finding bacterial disease in its caterpillars by F. Martin Brown, that their pronounced scarcity in certain years might be connected with poison intended for Gypsy Moth—the Monarch playing the part of "innocent bystander." The abundance this year in Connecticut and Massachusetts of *Alypia argillacea* accompanied by some *Haliotis obsoleta* was also noted.

Mr. Leng mentioned the finding on Staten Island by Messrs. Burke, Stecher and Davis of *Ptinella querci* and *Zaglyptus sulcatus* in a much decayed black birch log at Willow Brook.

Mr. Wm. T. Davis showed two walking-stick insects, *Manomera atlantica* Davis, collected on Staten Island in the Fort Wadsworth Reservation at the Narores. The adult specimen found on a golden rod August 4, died September 4, 1930. It laid fifty-three eggs during its captivity, some of which were shown, together with several of the attenuated masses of excrement about 4 millimeters in length. This species was first described in 1923, Staten Island being the type locality, and while diligent search has been made for males, none have been found. Males of the closely allied *Manomera blatchleyi* of Indiana, Illinois, etc., have been collected.

Mr. Bromley said that further observations at the Bartlett Tree Research Laboratories on the Norway maple stem miner, *Nepticula sericopeza* Zeller, a European moth first discovered in this country near Stamford, Connecti-

cut, where it was causing partial defoliation to Norway maples have shown that this season the species reverted to its original habit of mining the seed key. An abundance of seeds were produced this season by the Norway maple and the infestation of this insect was practically confined to these. It is thought that the leaf stem mining is secondary, occurring when seed keys are scarce. The moth itself is a small, satiny, black species with silvery spots on the wings and an orange tuft on the head and may be found in the day-time resting on the bark of the Norway maple trees.

The cynipids producing the woody oak galls are known to have a complicated life history. Studies on the species causing the so-called horned galls on pin oak have shown that the alternate generation produces small galls on the leaves and is of short duration, but that the generation occurring in the woody galls probably takes at least two years to develop.

Mr. Bromley did some collecting during the past season on eastern Long Island, in the region near Wading River, where the Asilid fauna was found to be varied and abundant. A species new to the New York State list was taken, namely *Bombomima virginica* Banks.

A trip to the sand hill region of South Carolina during the latter part of August and early September also yielded some very interesting species of robberflies. Among the specimens taken was the large bumble bee-like *Mallophora rex* Bromley. Note was made of the abundance of the large cicada, *Tibicen resonans*, whose loud song reverbrates in the open pine lands. The song is somewhat similar to that of our *Tibicen auletes*, but the cadence is quicker and the tone is louder and more penetrating.

MEETING OF OCTOBER 21, 1930

A regular meeting of the New York Entomological Society was held on October 21, 1930.

The meeting was called to order at 8:10 P. M. in the Society's room at the American Museum of Natural History. The President, Mr. Davis, in the chair.

In the absence of Mr. Leng, Mr. Buckes was appointed Secretary pro tempore.

Mr. Davis announced on the part of the program committee that at the meeting of November 18th Mr. S. W. Bromley would speak on "Hornet Habits."

Mr. Curran then read his paper on the collecting of flies. His tale regaled the Society with collecting incidents of the past years. During the course of the paper, the speaker brought up the very interesting question as to why certain species occur in periodic abundance alternating with periodic scarcity. He found this particularly true of the *Dolichopidæ* and believed that the only sollution of the problem lay in making more observations of the habits and habitats of the species in the field. Thereupon Mr. Curran read some notes on the mating habits of certain species of the *Dolichopidæ*, emphasizing the fact that very little is known of the larvæ and other im-

mature stages of these flies. In many species of adults that were observed, it appears that the males are distinctlyely marked, in such a way as to represent secondary sexual characters and that prior to the actual mating an elaborate courtship between the sexes takes place. The males frequently take a position a short distance in front of the females and in various ways "show off" their striking markings, the males usually taking up such positions that the females will get the best view of their elaborate secondary sex characters. In certain species the males hover near the females and rapidly vibrate their wings before alighting on the female; the first trials are invariably unsuccessful and the procedure is repeated, sometimes a hundredfold. This is quite characteristic of the genus *Dolichopus*. In *D. plumipes* and *D. aldrichi* and many other species the tarsi of either the front or middle legs are provided with long fringes of hair which are waved in front of the females and in *D. plumipes* the male actually strokes the face of the female with the fringe.

After reading his paper Mr. Curran showed some lantern slides of pictures he had taken while on a trip to the Canal Zone. He emphasized the fact that the Sanitary Corps of the U. S. Army had produced an almost malaria—and yellow fever-free territory in this region. The slides illustrated a number of characteristic, Panama insects.

The paper was opened for discussion and Mr. Davis remarked that the gregarious habits of certain species might account for their limited distribution and their periodic scarcity, remarking that he felt that in many cases there were not enough individuals of the species to go around.

Mr. Glanz exhibited some exotic beetles which had been relaxed and prepared very quickly by him by a method which he promises to communicate to the Society.

Mr. Davis recalled the question raised by Dr. Lutz as to whether or not the scarcity of the monarch caterpillar was due to the infection of its caterpillars with the introduced gypsy moth disease. Mr. Davis read some records that showed there had been certain periods of scarcity prior to the introduction of that disease. While in 1922 and 1923 *D. plexippus* was very abundant, in 1920 only five specimens had been recorded from the metropolitan area by Mr. Frank E. Watson as recorded in the *Journal of the New York Entomological Society* for 1921.

Mr. Bromley remarked that in 1914 it had likewise been very scarce.

Mr. Davis opened a discussion on the destructiveness of cicadas. The *Asparagus* growers of Florida have been experiencing trouble with certain species, the immature stages of the insects feeding upon the root stocks of *A. plumosa*. Two species seem to be involved, viz: *Diceroprocta olympusa* and *Tibicen davisii*. Ironically *T. davisii* seems to be the cause of the trouble. Mr. Davis read extracts from an article by Mr. J. W. Wilson, in the September, 1930, number of the Florida Entomologist on the injury caused by cicadas at Jupiter. The article, however, does not mention the species, for at the time it was written identifications had not been received by Mr. Wilson.

Mr. Bromley exhibited some insects collected by Mr. E. Larch. These were Diptera and Hymenoptera.

Dr. Melander reported on his summer's activities, stating that he had collected at Redding, Connecticut and in the Maine woods. During the summer he revised his collection of Tabanidæ. He related how Mr. Shannon collected the rabbit bot-fly *Cuterebra sp.* along hillsides in Washington (State) by throwing clods of earth at flies out of reach and finding that the flies followed the bits of dirt to within capturing distance.

Mr. Davis wanted to know how the bot-fly larvæ got into the rabbits. The question remains unanswered.

Several members reported that they had found from experience that excellent collecting could be had on the insides of window panes of railroad stations, where lights attract the insects and the station rooms act as traps from which there is no easy escape.

HERBERT RUCKES,
Secretary, pro tem.

ERRATA

Please note below the correction of certain errors appearing in "A List of Hesperiidæ from Barro Colorado Island, Canal Zone, and Adjacent Panama," published in the March issue of this Journal:

Page 98, 1st line, read *Cobalus virbius* Cramer, (not *viribius*).

Page 104, 15th line, read *calvina*, (not *valvina*).

Page 106, 29th line, read *crotona* Hewitson, (not *cotona*).

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IS A BEE ATTRACTED TO CLOVER BLOSSOMS BY ODOR?

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Introduction

Since Darwin's (6) experimental proof, that cross fertilization has decided advantages over self fertilization, pollination by honey-bee has become a common practice. Hendrickson (7) showed that insects may be necessary for the application of the pollen, even of some self-fertilized varieties. Alderman (1) and Auchter (2) showed increase of fruit setting by bees.

Most entomologists, such as Barrows (3), Lovell (10) and McIndoo (14) have advocated that bees respond to odor. Others as Bulman (4), Lovell (9) and Clements and Long (5), attribute the visit of honey-bees to an attractive color of flowers. Many botanists agree with the latter view. For instance Holman and Robbins say "In typical flowers, the petals attract insects" (8). In fact they think, that in the evolution of flowers, color changes have taken place because of their symbiotic relationship with the bee or other pollinating insects.

In many experiments, at least those in which oligotropism has been studied, some artificial odor or odors (not of the same species of flowers) have been used. Thus one of the main points, namely, whether the bee prefers a specific odor or color in a particular flower has been neglected. Yet this problem is not only of theoretical importance but also of practical significance as pointed out by Malhotra (11).

The lack of specific color and odor information in this connection seems to be for want of a reliable method of securing a reasonable amount of odorous material of a type of flower to be studied and the use of such a product under strictly analytical conditions. An attempt has been made to develop such a method. It may be capable of not only studying the odor responses in bees but may also yield similar information with reference to other pollinating insects.

Methods and Materials

Six hives of 100 black or German honey-bees were secured. Six tents 5 × 7 × 8 feet were prepared by using a single layer of cheese-cloth and wooden frames. A bee hive was placed in each tent, which was sealed to the ground.

A red clover field with abundant pollen was selected. Twenty grams of pollen and about 150 grams of flowers were collected in air-tight phials. It was recognized previously, as stated by Malhotra (12) that odor in flowers is due to an ester or esters. About 5–7 cc. of these esters were separated by fractional distillation (15). This product was further treated in order to obtain a more concentrated odor of clover flowers.

A filter-paper thimble, as used in the Soxlet extraction apparatus, was prepared. After putting three grams of pollen in, it was sealed. The use of a special thimble was necessary, since it was found by preliminary trials that any type of manufactured thimble, at present used in chemical laboratories, would be unsatisfactory for pollen extracting, first, because pollen may be easily damaged, and second, because it is very light and might float in an open thimble as soon as the condensed drops of the medium fall directly on it. The pollen was deprived of its essential oils (odorous material) by extracting it with petrolic ether (range 32° C.) for ten hours (at a special adjusted electric hot plate) by means of the Soxlet extraction method (13). Ether extracted pollen was divided into ten lots of about half a gram each.

The remaining pollen was weighed very accurately (four decimal places) in lots of about a half gram each. Microscopic slides were thoroughly cleaned, dried at 40° C., cooled in a desic-

cator and accurately weighed. About four drops of honey (secured from bees of the same species and out of the same clover field) were placed on each slide. This weighed honey was entirely covered by pollen.

Treated and untreated pollen was divided into various lots. Lot A contained normal pollen. Pollen of lot B was deprived of odor and color. To pollen of lot C, two drops of essential oil extracted from clover flowers were added. Pollen of lot D was treated similarly to lot B, except that it was colored as normal pollen. Two slides of each lot were placed in each tent for a week. The experiment was repeated four times for a month.

The slides with the unused material were dried, cooled and weighed as before. Loss of pollen was figured on a percentage basis. It was assumed, that the loss of pollen weight was due to its being carried away by bees and that the more frequent the visits, the greater the loss. Difference in various lots, with respect to weight loss, may be attributed to difference in attraction of flowers.

Results in repeated experiments appear to be very similar within various lots. However, for economy of space, the data for only one representative experiment will be reported in this paper.

Presentation of Data and Summary

Data presented in Table I seems to indicate that pollen, to which odorous material almost similar to that found in natural

TABLE I

DATA SHOWING PERCENTAGE LOSS OF POLLEN DUE TO VISITS OF BEES

Lot No.	Description of Pollen Treatment	Percentage Loss of Pollen	Observational Remarks
A	Normal pollen	58.00	Visits very frequent
B	Pollen minus color and odorous material	11.00	Frequently visited
C	Pollen plus odorous material	66.7	Very few visited
D	Pollen like B plus color of pollen	13.6	Few visits

clover flowers was added, was most favorable for attracting bees, as indicated by the percentage loss of pollen under the conditions of this experiment. Normal pollen (Lot A) attracted little less than Lot C. Pollen artificially colored but deprived of odor (Lot D) attracted bees little better than pollen in which both color and odor of a natural clover flower (Lot B) were absent. However, the difference between lots B and D is so small that it can fall within the range of an experimental error.

In general, it would seem from the data presented above, that this race of bees is primarily attracted to clover flowers due to odor rather than color, at least during the course of this study. This may or may not be the only mechanism in all or most cases, since only one kind of flower and a single species of bees have been used. This study is being extended, and may show any divergence of these insects in this respect. So far as this study goes, it seems that odor attracts bees to a larger extent than color.

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NEW SPECIES OF DISONYCHA AND NOTES (COL. CHRYSOMELIDÆ)

BY CHAS. SCHAEFFER
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The following notes and descriptions are a part of others on North American Chrysomelidæ made at odd times in previous years and were intended to be included in a larger paper now in preparation. However, for various reasons it is thought advisable to publish them separately.

Disonycha quinquevittata Say.

Dr. Leconte's *puncticollis* and *punctigera* are at least good races, not plain synonyms of *quinquevittata* and should be recognized as such; his *pluriligata* is the same as Say's species. *D. fumata,* as already pointed out by me does not belong in this group but is what Dr. Horn wrongly identified as the Mexican *crenicollis,* which apparently does not occur in the U. S. Judging from the localities given by Dr. Horn it seems that he associated several distinct forms with his *crenicollis. D. capitata* Jac., described from Mexico is the same as var. *pura* Lec., and should be placed with the latter as a synonym.

The locality Florida for *punctigera* in the Leng catalogue is wrong. It was described from Kansas and is rather widely distributed in the west. Typical specimens from Kansas of this race differ from *quinquevittata* in having a narrower black median vitta on each elytron, the prothorax usually a little wider and the elytra more distinctly and closely punctate, which, however, is more or less variable in both. Typical *quinquevittata* from Missouri, Kansas and Texas have a rather wide, black elytra vitta, slightly narrower prothorax, elytra usually more finely, sparsely punctate, the surface more shining, and the posterior part of the head rather sparsely punctate, at least in nearly all my specimens. Besides the localities mentioned I have specimens from Indianapolis, Ind., and Detroit, Mich.

A number of specimens from northern New York and Long Island, also a large series from Michigan, some from Iowa, Minne-

sota, Wisconsin and New Hampshire and Toronto, Canada, are very close to *punctigera*, but have a slightly wider prothorax and usually differently colored legs, though this is variable and certain specimens are difficult to place. The large series from Michigan shows a good deal of variation in regard to the median elytral vitta, which seems to be rather unusual in this genus. Some of these specimens are normally marked; in others the median elytral vitta is absent, but the two extremes are connected by intermediate specimens. The same variation occurs also in specimens from Idaho and Toronto, Canada, but not in those from northern New York and Long Island nor in typical *punctigera*.

The California var. *puncticollis* is shorter and somewhat more robust; the pronotum is usually very dull and the elytral vittae are rather wide as in typical *quinquevittata*, though specimens with narrow vittae occur. The var. *pura* is smaller and narrower than *punctigera* with relatively narrower prothorax, narrow median vitta on each elytron and usually the underside and legs pale except apex of tibiæ and tarsi black. In this form the lateral elytral vittæ are occasionally very faint and almost invisible. It occurs in Arizona and Mexico.

Besides those mentioned above I have three females from Cincinnati, Ohio, which seem to be different. They are narrower and more elongate than typical *punctigera*, the pronotum with only two black spots, the punctures on elytra denser and larger. A single female from Bening, Ga., has the elytral vittæ narrow as in *punctigera* but the prothorax narrower, more like in *quadrivittata* in form and the labrum entirely pale. I leave these with a few others for future investigations.

The punctation of the head used by Dr. Horn to separate *quinquevittata* and varieties from the other species, which have the ventral segments densely and finely punctate is variable. In some specimens the punctation is rather sparse, not punctured from side to side, leaving a distinct smooth space at middle. However, another character, apparently not noted before, separating these from the rest of the species except *abbreviata* and allies, is the more or less distinctly triangular emarginate labrum, which is in *caroliniana* and allies truncate at apex or at most broadly shallowly emarginate.

Disonycha asteris Schffr.

When I described this species I remarked on the close relationship of this to my *latifrons*, but with the material I had of both each appeared quite distinct. Additional material received since, also from different other localities, show the variability of the characters I used to separate them and therefore would place *asteris* as a variety of *latifrons*.

Disonycha brevicornis new species.

Similar in form to *caroliniana*, head pale, frontal tubercles, carina and neck black; near the eyes a few coarse punctures; labrum black, anteriorly truncate; antennæ black, first three joints more or less pale, third and fourth joints equal, outer joints short and somewhat stout. Prothorax slightly narrower than the elytra; sides rather feebly, arcuately narrowing to apex; apical and basal angles obtuse; surface scarcely punctate, pale, with two median dots and a short line below these black, also a larger black spot laterally on each side. Scutellum black. Elytra finely not densely punctate, pale with the usual, black sutural, medium and lateral vittæ, the median vitta slightly narrower than the pale space each side and with a distinct, though not strong, longitudinal, median elevation. Below, metasternum and ventral segments black except apical margins and the last pale; ventral segments moderately closely but not densely punctate and rather sparsely pubescent; femora reddish, anterior and middle one more or less black at base, tibiæ and tarsi black. Length 5.5 mm.

Colorado.

The three specimens before me are males, and judging from the slight costiform elevation on the median vitta, females may have the elytra distinctly costate and more or less longitudinally sulcate as in *pennsylvanica* and allies.

The color of the underside varies in the three specimens. Two have the ventral segments infuscate at middle and the anterior and middle femora are only slightly infuscate at base, another specimen has all the ventral segments black including the last but with more or less distinct pale apical margins and all the femora black at base. The punctation of the ventral segments is rather intermediate between the densely and sparsely punctate groups.

The short and rather stout antennal joints separate this distinct little species from those having the ventral segments largely black.

Disonycha nigriventris new species.

Underside and legs entirely black, except hind femora, which have a small reddish spot near apex; head black except antennal cavities and anterior margin of clypeus which are reddish; prothorax flavous with the usual large median and lateral spots of *unipunctata* and allies more or less transversely united, without distinct callus laterally. Elytra flavous with the usual sutural, median and lateral vittæ black, the median vitta as wide as the pale space each side; surface finely and sparsely punctulate. Length: 6 mm.

Oregon: Blitzen River; Idaho; Montana: Great Falls.

The type is a male from Oregon, the female has the elytra costate and longitudinally sulcate.

The color of the femora is variable, in some specimens the middle and hind femora are more red, but the ventral segments are apparently always entirely black including the last. The pronotal spots are as in some specimens of *uniguttata*, that is, a large one at middle, wider at apex and one on each side, these often unite forming an irregular transverse fascia.

This species is a member of the *pennsylvanica* group and has the general coloration of limbicollis but the pronotum has no lateral callosities and the elytra are finely, rather indistinctly punctulate. The ædeagus, extracted from one male, appears to be different from anything figured by Mrs. Blake.*

The key to the species of Disonycha* of the *pennsylvanica* group recently published by Mrs. Blake is apparently a provisional one covering only the typical specimens of each species, possibly to be replaced by a more complete key in her coming revision. The coloration, largely used in the key, is variable in the different species. *D. uniguttata* varies from having reddish legs except tarsi, which are infuscate, to legs with abdomen and head black. These latter, following her key, would be identified as *limbicollis* by those not having specimens of the latter for comparison; *nigriventris* also would be associated with it.

I have a series of specimens from Louisiana and Arkansas which, following the key, would be placed with her *pallipes;* a few of these specimens have the legs entirely black, except hind femora, which show a more or less distinct reddish spot. How-

* Bull. Brookl. Ent. Soc. XXV, 1930, p. 210, plate 13.

ever, they are more like *pennsylvanica* than *pallipes,* though the ædeagus extracted from one male seems to be different from those figured by Mrs. Blake. With her identification of *pallipes* Cr., I do not agree. Crotch made it a variety of *limbicollis,* the latter with distinct thoracic callus which, if absent in *pallipes,* would have been mentioned by him as he did in *pennsylvanica. D. pallipes* Cr., is in my opinion the same as *uniguttata* and the *pallipes* of Mrs. Blake is *procera* Cas., which name should be used for this species. Casey undoubtedly came to the same conclusion and possibly saw typical Crotch specimens of *pallipes* before Dr. Horn rearranged the species in the Leconte collection according to his own view at the time he revised the Halticini.

Mrs. Blake in her identification of *pallipes* seems to have been influenced by the specimens in the Brooklyn Museum material sent to Washington identified by me as *pallipes,* also in that of the National Museum identified by Dr. Schwarz as that species. The following explanation will clear this point. On one of my visits to the National Museum some years ago F. Knab came over to the office of Dr. Schwarz and in the general talk and discussions the matter of variation, wrong identification, etc., came up and Knab among other things called our attention to the wrong identification of *pennsylvanica* and the distinctness of *uniguttata* Say. Some time later after my return I remembered Knab's remarks and after comparing specimens with the description of *uniguttata* I found that he was correct and separated these from the rest of the specimens, which all were labelled *pallipes.* At the time I did not investigate *procera* and *pallipes* and the remaining specimens were left under the latter name. However, later, when I took up the matter again and using only my own material I overlooked changing the name on the specimens in the museum collection. If *uniguttata* was recognized and separated in the National Museum collection then Dr. Schwarz had done undoubtedly the same thing as I did at first.

Disonycha neglecta new species.

Pale flavous, pronotum with four dark spots and a short, more or less distinct median line; elytra with narrow, black sutural median and lateral vittae.

Head pale, antennal joints elongate, black the first three pale below, labrum black, apical margin truncate; interocular carina moderately dis-

tinct; frontal tubercles distinct, but flat; sparsely punctate near each eye. Prothorax nearly as wide as the elytra, sides feebly arcuately narrowing apically, basal and apical angles obtuse, surface indistinctly punctate. Elytra distinctly and closely punctate, the black median vitta much narrower than the pale space each side. Underside pale, except median part of prosternum, apex of tibiæ more or less and tarsi blackish; ventral segments rather densely punctate and pubescent. Length: 6.5 mm.

Kansas, Arizona, Utah, Oregon.

The type is a male from Kansas. The Arizona and Utah specimens have the ventral segments blackish at apex and the tibiæ in the Utah specimen are black on the internal edge, otherwise they are like the Kansas type.

This species has nearly the form of *latifrons* but the underside is pale and the space between antennæ and clypeus is not flat but convex and rather subcarinate.

Disonycha laticollis new species.

Similar in form to *caroliniana* but much larger, with relatively wider prothorax and sutural and lateral vittæ confluent at apex. Head pale, a small punctate, depressed area near each eye; frontal tubercles moderately distinct, flat; clypeus and interantennal space feebly convex, nearly flat: labrum black, apical margin subtruncate; antennal joints moderately elongate, black basal joint pale below. Prothorax transverse at base as wide as the elytra, about one and a half times as wide at base as long; sides moderately, arcuately narrowing to apex, apical and basal angles obtuse; surface smooth with two median black spots, a rather indistinct lateral spot on each side and a short line below the two central spots pale brown. Elytra with the usual sutural, median and lateral vittæ, the sutural and lateral vittæ uniting at apex, the median vitta slightly narrower than the pale space each side; surface distinctly but rather finely punctate, punctures well separated. Body below pale, metasternum black, ventral segments with a more or less distinct dark line at apex and somewhat densely punctate, pubescence moderate; femora red, tibiæ and tarsi black. Length 7.5 mm.

New York: Wyandanch, June, and Yaphank, Sept., Long Island.

This species is not unlike in form to *lodingi* which has narrower and longer antennal joints and the elytra are smooth and more shining.

Two specimens from Casco Bay, Maine, which I place provisionally with this species, have the elytra impunctate and more shining and the hind angles of prothorax are distinct.

Disonycha punctipennis new species.

Form less oval than *caroliniana,* elytra distinctly and closely punctate. Head flavous, a few moderately coarse punctures near each eye; frontal

tubercles moderately distinct; frontal carina distinct; labrum black, truncate at apex; antennal joints moderately elongate, black, three basal joints pale below. Prothorax nearly as wide as the elytra; sides moderately arcuately narrowing apically, apical and basal angles obtuse; surface shining and more or less distintcly punctate, anteriorly at middle two black spots and one lateral spot on each side. Elytra more parallel than in *caroliniana* with the usual sutural, median and lateral vittæ, the median vitta much narrower than the pale space each side; surface shining and moderately densely punctate. Below pale metasternum infuscate apically at middle; ventral segments densely punctate and moderately pubescent; legs pale, internal edge and apex of tibiæ and tarsi black. Length: 7 mm.

Iowa: Lake Okoboji, July (Buchanan). Minnesota.

Type and paratypes in National Museum, also paratypes in my collection.

The very distinct, rather dense punctation of the elytra and the somewhat more parallel form separates this from allied species.

Disonycha stenosticha new species.

Pale flavous, pronotum without any dark markings and elytra with new narrow, lineate, median vittæ.

Head pale, with a few rather indistinct punctures near each eye; frontal tubercles flat; frontal carina distinct, labrum pale, truncate anteriorly; antennæ reaching backwards to the middle of elytra, joints elongate, black, the first three pale beneath. Prothorax narrower than elytra; sides not strongly arcuately narrowing to apex; apical angles rounded, basal angles obtuse; surface smooth and shining, not punctate nor marked with black spots. Elytra slightly wider than the prothorax at base, shining, impunctate, with the black sutural, median and lateral vittæ very narrow. Body below flavous; ventral segments moderately closely punctate and feebly pubescent; legs pale, tarsi black. Length: 7 mm.

Texas: Brownsville, Jan.

The single female of this distinct species was given me by Mr. Gentner.

This species is less oval than most of the *caroliniana* group and similar in form to the variety *puncticollis*. This together with the smooth surface, general coloration and the very narrow elytral vittæ should easily identify *stenosticha*.

ANOTHER MINIATURE PORTRAIT OF THOMAS SAY AND OTHER SAY NOTES

BY HARRY B. WEISS AND GRACE M. ZIEGLER

When our biography of Thomas Say was published, we were somewhat of the opinion that certain sources of original material had been exhausted. We were led to believe that this was so because of our failure to find anything during the year previous to publication. However, no one has the privilege of saying the last word upon anything—and we are glad to present the following information which has come to light since the book appeared.

Mr. Frederic Fairchild Sherman, of New York City, very kindly called our attention to a miniature portrait of Thomas Say, which was painted by M. Binsse de Saint-Victor, maternal grandfather of John LaFarge, and furnished the photograph which accompanies these notes. It shows Say in the years of his youth and is, according to Mr. Sherman, "a beautifully painted ivory."

M. Binsse de Saint-Victor, formerly a planter in San Domingo, came to this country in 1806, a refugee from San Domingo, and landed in Philadelphia. Later, New York City was his residence. According to "John LaFarge, a Memoir and a Study" by Royal Cortissoz (Boston, 1911), John LaFarge, who clearly remembered his grandfather, is quoted as follows:

"He happened to have somewhat of an artistic temperament —it was in the family; and he was as gentle and amiable as his more celebrated brother, the father of Paul de Saint-Victor, was not. My grandfather took to painting miniatures and giving drawing lessons and learned his art as he went along. I dare say some of his miniatures may still exist. On a small scale he was an exquisite painter. He was also a good teacher and started me at six years old in the traditions of the eighteenth century."

On page 229 of "Thomas Say, Early American Naturalist" (Springfield, 1931), reference is made to the portrait of Thomas

Say most commonly used in connection with accounts of his life—a steel engraving by Meyer from a portrait by Joseph Wood—and the statement is made that the original does not appear to exist. On March 13, 1931, Miss Helen Juliet Kobbé, of 70 East 96th Street, New York City, wrote that the original, "a small oil-painting on wood, measuring 8½ inches by 6¾ inches," was in her possession. Miss Kobbé said, "I am glad to know who was supposed to be the artist. Mrs. Say's youngest sister, Sarah Lord Kobbé, was my grandmother, and Mrs. Say lived next door to our family during those years on Staten Island, when as a young girl, I used to sit with her daily, and listen to her talk of her loved husband, and the interesting friends he had.

"The portrait in question hung in her room, and either at her departure for Milton she gave it to my father, her nephew, or it was sent him at her death. . . . I find the following inscription on the back of the portrait—'Portrait of Mr. Say—painted either before his departure with Maj. Long, or just after his return from the Rocky Mountains—1819–20.' . . . The colors are very dark, or dull from age."

Another interesting item is Rafinesque's criticism of Say's "American Entomology." This was published in the "American Monthly Magazine and Critical Review," vol. II, no. 2, p. 143, 1817. This journal was founded by H. Biglow in May, 1817, in New York City, but existed only two years, 1817 and 1818. Rafinesque edited the department entitled "Museum of Natural Sciences" and was one of the notable contributors to the magazine. His review of Say's work is quoted in full as follows:

"American Entomology or Descriptions of the Insects of North America, illustrated by coloured figures from drawings executed from nature, by Thomas Say, Philadelphia, Mitchell and Ames, 8vo first number pp. 40. with six plates and an engraved frontispiece.

"The United States can at last boast of having a learned and enlightened Entomologist in Mr. Say. Those who have preceded him, such as Catesby, Abbot, Melsheimer, Muhlenberg, Barton, Escher, Leconte, Torrey, &c. have merely been collectors, or painters, or nomenclators; but the author of this work shows

himself acquainted with the details and improvements of the science; he is at the same time an acute observer and an able painter. This increases our regret that instead of aiming at the glorious title of the American Fabricius, his utmost ambition is to tread in the steps of Donovan! and imitate his uncouth arrangements, desultory style, pompous publications, and costly performances. We regret exceedingly to see those defective modes introduced by the author of this work, and are sorry to foresee that they are not likely to promote his views. This was not the manner in which the labours of Linneus, Fabricius, and Latreille have been published, yet they are the classical authors of the science. It is true that we are offered an elegant specimen of typography; but the price of it is two dollars. For that sum we have forty pages (of which twelve are quite blank!) printed on beautiful paper and type, and six fine coloured plates, containing only eight species (whereof five are new) of insects, while they might have included sixty! Therefore at this rate, as there are at least eight thousand species of insects in North America, the sum of two thousand dollars will be requisite in order to admire the insects on this new plan! while on the plan of Linneus, &c. ten dollars might be quite sufficient. It would be well if this style was left for the use of the princes and lords of Europe. When this work shall proceed, we may endeavour to review it at length. C. S. R."

THOMAS SAY

NEW RECORDS OF MICROLEPIDOPTERA FROM NEW YORK

By ALEXANDER B. KLOTS
ITHACA, N. Y.

A large proportion of the following records is the result of collecting at the Cornell trap-light in the spring of 1930. The remainder are records of the writer from previous years, both from Ithaca and other parts of the state. Unless otherwise stated all collecting was done by the writer. All specimens have been compared with the Cornell University Department of Entomology collection, and all doubtful identifications have been checked by comparison with the collection of the U. S. National Museum.

During the spring of 1930 an effort was made to obtain a larger number of Microlepidoptera than has formerly been done at Cornell by paying more frequent visits to the trap-light during the night instead of relying for collecting mainly upon the specimens that remained in the trap until morning. To a certain degree, therefore, the unusually large number of "micro" records is probably due to this procedure. Undoubtedly, however, as was shown by collecting in other parts of the east, the past season was in many ways an unusual one.

Three types of records have been included, as indicated by abbreviations in the left-hand margin. These are as follows:

State = record of a species hitherto unrecorded from New York.
Local = record of a new locality for a species previously recorded from New York.
Date = record for a date radically differing from those recorded in the State List.

HEPIALIDÆ

Local **Sthenopis argenteomaculatus** Harr. McLean 13 Je '30.

INCURVARIIDÆ

Local **Incurvaria russatella** Clem. McLean 6 Je '28.

NEPTICULIDÆ

State **Nepticula nigriverticella** Cham. Ithaca 16 Je '30.
State **N. populetorum** F. & B. Ithaca 14–16 Je '30.
State **N. saginella** Clem. Ithaca 5–16 Je '30.

EUCLEIDÆ

Local **Tortricidia flexuosa** Grt. Copake Falls 24 Jy '28.
Local **T. pallida** H.-S. Copake Falls 20 Jy '28.
Local **Packardia geminata** Pck. Ithaca 24 Je '30.

TINEIDÆ

State **Tinea marmorella** Cham. Ithaca 23 May '30.
State **Diachorisia chrysoadspersella** Dietz. Ithaca 3 Aug '28.
State **Leucomele miriamella** Deitz. Ithaca 13, 16, 18 Je '30.

LYONETIIDÆ

State **Lyonetia speculella** Clem. Ithaca 12 Je '30.

GRACILARIIDÆ

State **Parornix preciosella** Dietz. Ithaca 22 May '30.
Local **Gracilaria syringella** Fabr. Ithaca 12 May–2 Je '30.
Local **Acrocercops strigifinitella** Clem. Ithaca 12 Je. '30.
Date **A. venustella** Clem. Ithaca 4 Je '30.
State **Marmara auratella** Braun. Ithaca 16 Je '30.
State **Lithocolletis quercialbella** Fitch. Ithaca 13 May–1 Je '30.
Local **L. argentinotella** Clem. Ithaca 4 Je '30.
Local **L. basistrigella** Clem. Ithaca 1–16 Je '30.
Date **L. lentella** Braun. Ithaca 23 May–12 Je '30.

GELECHIIDÆ

State **Trichotaphe purpureofusca** Wlsm. Ithaca 5 Je '30.
State **Stomopteryx palpilineela** Cham. Ithaca 6 Je '30.
Local **Enchrysa dissectella** Z. Ithaca 25, 26 Je '30. Coll. by A. Glenn Richards, Jr.
Local **Evippe prunifoliella** Cham. Ithaca 13 Je '30.

LAVERNIDÆ

Local **Psacaphora terminella engelella** Busck. Ithaca 7 Je '30.
State **Stagmatophora ceanothiella** Cozens. Ithaca 22 May '30.
State **Batrachedra trichella** Busck. Ithaca 4 Aug. '28.

YPONOMEUTIDÆ

Local **Argyresthia conjugella** Z. Ithaca 1, 14 Je '30.

AEGERIIDÆ

Local **Conopia pyralidiformis** Wlk. Ithaca 6 Aug. '28.

TORTRICIDÆ

Local **Epinotia vertumnana** Z. Ithaca 4 Apr. '29.

Local **Ancylis floridana** Z. McLean 16 May '30.

Local **Anchylopera platanana** Clem. Taughannock Falls State Park 28 May '30.

Local **Eucosma tocullionana** Heinr. Ithaca 13 Je '30.

!! **Rhyacionia gemistrigulana** Kf. Ithaca 11 Je '30. One previous record.

Local **Gretchina bolliana** Sling. Ithaca 27 May '30.

State **Olethreutes variegana** Hübn. Ithaca 16 Je '30.

State **Cymolomia ferriferana** Walk. Ithaca 12 Je '28, 18 Je '30.

Local **Sparganothis reticulatana** f. **gracilana** Wals. Connecticut Hill, Trumbull Corner, (alt. 2,000 ft.) 31 Jy '28.

Local **Argyrotoxa curvalana** Kearf. Ithaca 11 Jy '28.

State **Peronea** n. sp.? near **trisignana** Robinson. McLean. Larva a roller on *Cornus*, emerged 24 Je '30, bred by writer.

Local **Eulia mariana** Fern. McLean 16 May '30.

CARPOSINIDÆ

Local **Bondia crescentella** Wals. Ithaca 13 May '30.

PYRALIDIDÆ

Local **Polloccia alticolalis** Dyar. Lake Tiorati, Palisades Interstate Park, 24 Aug. '26.

Local **Loxostegopsis merrickalis** B. & McD. Lake Cohasset, Palisades Interstate Park, 16 Aug. '26.

Date **Rhodophaea exsulella** Z. Ithaca 16 Je '30.

Local **Glyptocera consobrinella** Z. Ithaca 12 Je '30.

!! **Elasmopalpus lignosellus** Z. Ithaca 6 Aug '28. One previous record.

Local **Moodna pelviculella** Hulst. Lake Tiorati, Palisades Interstate Park, 1 Aug. '26.

PTEROPHORIDÆ

Local **Platyptilia tesseradactyla** L. McLean 13 May '30.

Local **P. carduidactyla** Rly. Greenwood Lake, 10 May '30.

IS ECITON MEXICANUM F. SMITH REALLY ECITON PILOSUS F. SMITH?*

BY M. R. SMITH
A. & M. COLLEGE, MISSISSIPPI

In 1858 F. Smith described a species of ant, *Eciton* (*A.*) *pilosus,* from the worker phase. From that date until the present time neither the queen nor the male have been discovered. A year later Smith described another *Eciton* from the male phase. This ant, *Eciton* (*A.*) *mexicanum,* is still known from only the male phase although it has been over seventy years since Smith first described the species. Since I have some data bearing on the identity of the two species, I believe it worth while to record it here. From the information at hand I am led to believe that the ant which F. Smith described as *E. mexicanum* is not a valid species, but is very probably the male of *Eciton pilosus.* If my assumption should prove correct, then the name *E. mexicanum* must be relegated to synonymy. The reasons which have led me to this hypothesis are given below.

During the summer of 1930 I received for determination a number of ants from Mr. J. P. Kislanko, of Wiggins, Mississippi. Among the lot was a number of specimens of male ants belonging to a species of *Eciton.* Mr. Kislanko stated that the specimens were collected at a light trap at Wiggins on the night of June 27. After carefully examining the ants I found that they agreed splendidly with Wheeler's remarks and figure of *Eciton mexicanum* F. Smith as given in his "Ants of Texas, New Mexico and Arizona." (Bull. Amer. Mus. Nat. Hist. Vol. 24, p. 414, f. 11, pl. 26 (1908).)

Previous to the date on which the males of *E. mexicanum* were collected at Wiggins, the genus *Eciton* (*Acamatus*) was represented in Mississippi by only four species, namely: *carolinensis, opacithorax, pilosus,* and *schmitti,* although rather general collecting for ants had been done over a period of ten years or more. Of these four species, males are known only for *opacithorax* and

* A contribution from the Mississippi Agricultural Experiment Station.

schmitti. There are thus two species of *Eciton* in Mississippi for which the male phase is not yet known.

It at once occurred to me that possibly the males (which are now known as *E. mexicanum*) might be the much-looked-for male of either *carolinensis* or *pilosus*. Since the type locality of *Eciton mexicanum* is Mexico, as the specific name suggests, and since *carolinensis* is not known to occur in Mexico, I at once inferred that he males at hand might very probably be the males of *Eciton pilosus*, an ant which is not only common to Mexico but ranges throughout the southern part of the United States, certainly as far east as Mathiston (Webster County) Mississippi.

Any one who has studied our North American species of *Eciton* (*Acamatus*) will quite readily agree that *opacithorax* and *carolinesnsis* are very closely allied taxonomically if one is to judge them by a study of the worker phase of the two species. Reasoning from this basis one would expect the male of *E. carolinesis* to be very similar in a general way to that of *E. opacithorax* and rather remote from the male of *E. pilosus*. Hence, since the specimens of *E. mexicanum* do not in any way agree with the male of *opacithorax*, and since **carolinensis** is not known to occur in Mexico, it is an easy inference that the males of *E. mexicanum* might be the long-sought males of *E. pilosus*.

One might, of course, argue that the males collected at Wiggins were blown into Mississippi by strong southern or western winds but this hypothesis is hardly tenable. The only conclusive proof that the species are the same would be the finding of the males of *E. pilosus* associated with workers in a nest. During the past summer I sought diligently for nests of this species, but without success. I believe my efforts will eventually be rewarded and what I have suggested here will prove to be a fact.

The present synonymy of the two species is as follows:

E. pilosum Fred Smith, Cat. Hym. Brit. Mus. Vol. 6, 151 (1858) worker.

E. pilosum Mayr, Novara Reise, Formic. p. 77 (1865), Wien Ent. Zeit. Vol. 5, p. 120 (1886); Dalla Torre, Cat. Hymen. Vol. 7, p. 5 (1893) worker; Emery Bull. Soc. Ent. Ital. Vol. 26, p. 183 (1894) worker; Forel, Biol. Centr. Am. Hym. Vol. 3, p. 27 (1899–1900) worker. Emery, Mem.

Real. Acad. Ist. Bologna, p. 16, (1900) worker; Wheeler, Amer. Nat. Vol. 35, p. 165 (1901) worker, Bull. Amer. Mus. Nat. Hist. Vol. 24, p. 412 (1908) worker.

E. clavicornis Norton, Trans. Amer. Ent. Soc. Vol. 2, p. 46 (1868) worker.

E. mexicanum (Fred Smith), Cat. Hym. Brit. Mus. Vol. 7, p. 7 (1859).

Labidus mexicanus Cresson, Trans. Amer. Ent. Soc. p. 194 (1872) male.

Eciton (Labidus) subsulcatum Mayr. Verh. Zool. bot. Ges. Wien, Vol. 36, p. 440 (1886) male.

Labidus subsulcatum Cresson, Trans. Amer. Ent. Soc. Suppl. Vol. p. 259 (1887) male.

Eciton mexicanum Dalla Torre, Cat. Hym. Vol. 7, p. 4 (1893) male; Emery, Zool. Jahrb. Syst. Vol. 8, p. 260 (1894) male, Mem. Acad. Sc. Bologna Vol. 8, p. 515, f. 19, (1900) male; Wheeler, Amer. Nat. Vol. 35, p. 165 (1901) male, Bull. Amer. Museum Nat. Hist. Vol. 24, p. 414, pl. 26, f. 11, (1908) male.

Eciton (Acamatus) mexicanum Emery, Mem. Real. Acad. Ist. Bologna p. 17, f. 19, (1900) male.

Author's note: Before submitting this article for publication I mailed it to Dr. W. M. Wheeler for suggestions and criticisms. In replying Dr. Wheeler referred me to his paper entitled, "Observations on Army Ants in British Guiana," Proc. Amer. Acad. Arts and Sci. Vol. 56, No. 8, pp. 291–328 (1921). Wheeler in studying some specimens collected by Mr. Wm. Beebe at Kartabo, in which males were taken along with workers, quickly realized that the workers were a new variety of *Eciton (Acamatus) pilosum,* which he named var. *beebei.* The males except for some minor differences showed very clearly that they were a variety of *Eciton (A.) mexicanus.* From such data Wheeler came to the conclusion that the name *E. (A.) mexicanum* should be relegated to synonymy since the male phase (the only phase that has ever been recognized) is nothing more than the male of *pilosus,* an ant which was described from the worker phase a year earlier than *mexicanum.*

As I reached a similar conclusion under somewhat different circumstances and absolutely ignorant of Dr. Wheeler's inferences, I have deemed it advisable to publish this article in that it tends to confirm Dr. Wheeler's conclusions.

In the same article Wheeler also describes for the first time both the female and male of *Eciton* (*A.*) *carolinensis*.

CLASSIFICATION OF THE OLD WORLD MEMBRACIDÆ

BY FREDERIC W. GODING

The characters usually recognized to separate the Membracidæ from the other Homoptera are: Head nearly vertical; ocelli situate between the eyes; antennæ minute, inserted in front of and between the eyes; beak arising from the mentum; pronotum convex, frequently with elevated processes, and usually prolonged posteriorly; tarsi with three articles.

A character called the "episternal hook" has been mentioned which according to McAtee and Malloch was observed in all the membracids examined by them. They claim that it distinguishes the group from all others, and describe it as follows: "Mesopleurum with a process or lobe either at or near antero-lateral angle, or just below middle of anterior margin, or both, processes which overlap the propleurum, in many cases fitting into excavations along posterior margin of that sclerite." Should this character be present in all membracids, and not in other groups, it would definitely limit the species to be included in the family.

No attempt has been made since Stal published his valuable synopses to include the Old World membracidæ in a generic classification; and, as many new genera have been recognized since then, it seems timely to arrange them all in a system whereby students may locate the various species in their correct generic position.

Buckton has well said "Biology ranges over the wide world, but it is obvious that identification of an insect is necessary before its habits and functions can be discussed." To identify these strange forms keys are herein presented which were based upon the species in my own collection, and the works in my library. The corresponding literature to and including the year 1926 is recorded in Funkhouser's Catalog, and since that date in the various scientific publications.

The genera preceded by an * are African; those by a † are Eastern, and those by * † have species in both regions.

KEY TO SUBFAMILIES

1(4). Scutellum more or less visible.
2(3). Pronotum without a posterior process ... . .. ÆTHALIONINÆ
3(2). Pronotum with a posterior process; scutellum sometimes aborted. CENTROTINÆ
4(1). Scutellum completely covered by sides of pronotum; third apical cell of tegmina truncate at base.
5(6). One or more pairs of tibiæ and usually apical margin of head foliaceously compressed . . . .. . MEMBRACINÆ
6(5). All tibiæ slender; apical margin of head not foliaceous DARNINÆ

ÆTHALIONINÆ

KEY TO TRIBES

1(2). Pronotum convex, unarmed; apical area of tegmina multicellular, clavus acuminate . . . *Æthalionini*
2(1). Pronotum cornute above each humeral; clavus acuminate *Tolanini*

Æthalionini

KEY TO GENERA

1(2). Apex of abdomen extended posteriorly in a slender hairy process long as the body; median carina of pronotum lunately elevated; tegmina coriaceous; wings with two apical cells †**Darthula** Kirkaldy, *Urophora* Gray.
2(1). Abdomen normal; median carina of pronotum not elevated; tegmina subhyaline; wings with three apical cells ***Coloborrhis** Germar, *Euryprosopum* Stal, *Bohemania* Stal, *Oclasma* Melichar.

Tolanini

KEY TO GENERA

1(2). Suprahumerals short, auricular; pronotum without a median carina, posterior margin concave; apex scutellum acute; venation of tegmina irregular; wings with four apical cells †**Porcorhinus** Goding
2(1). Suprahumerals prominent, conical; pronotum with a weak median carina, posterior margin truncate; apex of scutellum rounded, emarginate; tegmina hyaline, with two discoidal and five apical cells; wings with four apical cells . †**Hemicentrus** Melichar, *Sarritor* Distant.

CENTROTINÆ

KEY TO TRIBES

1(8). Wings with three apical cells; tegmina with two or three (rarely four discoidal and three or four or five apical cells, exceptionally the apical area multicellular; tibiæ usually simple.
2(7). Pronotum convex, unarmed, rarely with a short carina or small tubercle above each humeral.

3(6) Sides of chest destitute of small teeth.

4(5). Scutellum abortive or absent; apical angles of mesonotum more or less produced in spines; pronotum sometimes tuberculate; base of exterior discoidal cell of corium stylate . .. ... *Coccosterphini*

5(4) Scutellum complete; apical angles of mesonotum not produced. *Gargarini*

6(3). Sides of chest armed with one or two teeth *Ebhuloidesini*

7(2). Pronotum cornute above each humeral *Centrotini*

8(1). Wings with four apical cells; tegmina with two or three discoidal and five (rarely four) apical cells, apical area exceptionally multicellular.

9(10). Pronotum more or less gibbous, unarmed, rarely a slight tubercle or short carina above each humeral; apex of scutellum emarginate; legs simple . . *Uroxiphini*

10(9). Pronotum cornute above each humeral or the disk elevated in a high erect process; tibiæ rarely dilated and flattened.

11(14). Sides of chest not armed with teeth.

12(13). Pronotum cornute above each humeral; posterior process more or less distant from or impinging upon the scutellum, broad or slender at base; scutellum variable in length, the apex acute or emarginate *Leptocentrini*

13(12). Disk of pronotum elevated in a high nearly erect process its summit bilobed, or with a spine each side; posterior process slender, usually distant from the body; scutellum longer than broad, its apex usually acute *Micreunini*

14(11). Sides of chest armed with one or two teeth.

15(16). Disk of pronotum elevated in a recurved, erect, forward inclined or porrect process, its summit bilobed, bispined, bituberculate, or compressed; posterior process impinging upon or more or less distant from the scutellum, with or without subapical dorsal node; legs simple or tibiæ moderately dilated *Hypsauchenini*

16(15). Pronotum cornute above each humeral, surface covered with short spinules, or spinous tubercles, or rugose and nodulate; posterior process impinging upon or slightly separated from the scutellum, usually binodose, sometimes nearly straight; tegmina with two or three discoidal cells; tibiæ and apical margin of head usually foliaceous . *Centrocharesini*

Gargarini

KEY TO GENERA

1(10). Posterior process impinging upon scutellum.

2(5). Hind trochanters with small teeth on inner surface.

3(4). Humerals strongly produced in cornutiform processes; body about as broad as long; posterior process broad, triangular, depressed; pronotum rarely carinate above humerals . †**Sipylus** Stal

4(3). Humerals not strongly produced; body much longer than broad; posterior process slightly concave ......†**Centrotoscelus** Funkhouser

5(2). Hind trochanters not dentate on inner surface.

6(7). Posterior process laminately convexly dilated, apex briefly acute. †**Subrincator** Distant

7(6). Posterior process not laminately dilated.

8(9). Pronotum without short carina above each humeral. *†**Gargara** Amyot and Serville

9(8). Pronotum with a short carina above each humeral. †**Xanthosticta** Buckton, *Tiberianus* Distant

10(1). Posterior process more or less distant from the scutellum.

11(12). Base of posterior process slightly but distinctly separated from the scutellum, strongly sinuately waved; pronotum strongly gibbous and ridged, rarely with a short carina above each humeral .... †**Ebhul** Distant

12(11). Base of posterior process strongly arched above the scutellum; disk of pronotum gibbous.

13(16). Posterior process moderately sinuate, base thick, apical area slender, surface not spinose; tegmina much longer than abdomen.

14(15). Posterior process impinging upon margins of tegmina behind scutellum .... ***Kombazana** Distant

15(14). Posterior process robustly recurved to apex of scutellum then slender and linear, upwardly and backwardly recurved; pronotum with two ridged foveate spots near base ...... ***Promitor** Distant

16(13). Posterior process distant from the scutellum, strongly sinuate or undulate.

17(18). Pronotum not spinose, posterior process strongly convexly elevated to behind the scutellum, then impinging upon inner margins of tegmina and straight, acuminate; tegmina long as the abdomen. ***Umfilianus** Distant

18(17). Pronotum rugose, covered with spinules; posterior process thick, strongly undulate, not narrowed towards apex which ends in a long spine; tegmina slightly longer than the abdomen ***Hamma** Buckton

Ebhuloidesini

KEY TO GENERA

One genus belongs to this tribe which differs from the genus *Ebhul* Distant in having the sides of the chest armed with teeth. The type is *Ebhul notatus* Funkhouser, in Suppl. Ent. xv, p. 17, fig. 27. (1927), from Sumatra .... †**Ebhuloides** gen. nov.

Centrotini

KEY TO GENERA

1(12). Base of posterior process impinging upon the scutellum.

2(5). Posterior process laminate with or without a dorsal node; apical angle of tegmina acute.

3(4). Dorsal node of posterior process strongly convexly elevated; tips of suprahumerals more or less angulate.
†**Antialcides** Distant, *Pantaleon* Distant
4(3). Dorsal node of posterior process obsolete or absent; suprahumerals short, auricular .... †**Machærotypus** Uhler, *Maurya* Distant
5(2). Posterior process not laminate.
6(11). Hind trochanters spinose within; suprahumerals distant between bases.
7(10). Veins to apical cells of tegmina straight; posterior process robust, acuminate, not elevated, base broad, apex not or just passing apex of clavus.
8(9). Tips of suprahumerals truncate .... †**Otaris** Buckton
9(8). Tips of suprahumerals acute .. †**Tricentrus** Stal, *Taliopa* Buckton
10(7). Veins to apical cells of the vitreous tegmina curved; posterior process rather slender, its apex elevated and far passing apex of clavus .... †**Tricentroides** Distant
11(6). Hind trochanters destitute of spines within; suprahumerals contiguous for a space from bases, then diverging and inclined more or less forward .... ***Eumonocentrus** Schmidt, *Beninia* Distant
12(1). Base of posterior process more or less distant from the scutellum.
13(24). Posterior process distinctly angulate near base.
14(17). Suprahumerals contiguous or united for a space from bases or almost touching; posterior process broadly compressed, a short tooth at basal angle.
15(16). Bases of suprahumerals nearly contiguous, very long, subslender, curved outward and backward, tips dilated; posterior process cylindrical on basal third, toothed at basal angle and convexly curved, compressed, long as or longer than tegmina, margins usually spinose; scutellum longer than broad, apex obtuse or notched .... ***Paraxiphopœus** Goding
16(15). Bases of suprahumerals contiguous or united for a space then diverging, compressed, gradually acuminate; posterior process robust to basal angle then sinuate, compressed, shorter than tegmina, margins not spinose.
***Monocentrus** Melichar, *Basilides* Distant
17(14). Suprahumerals distant between bases; posterior process shorter than tegmina.
18(23). Suprahumerals directed obliquely outward and upward.
19(20). Posterior process compressed, nearly straight from basal angle, usually laterally carinate, inferior margin lobed at middle touching apex of scutellum.......... †**Maguva** Melichar, *Anchonoides* Distant
20(19). Posterior process not lobed beneath; suprahumerals long, robust.
21(22). Posterior process nearly straight from basal angle, slender, distant from scutellum, basal angle sometimes toothed; tips of suprahumerals truncate .... †***Anchon** Buckton

22(21). Base of posterior process, including disk of pronotum, robustly and angulately elevated but not distant from scutellum then concavely sinuate, without a basal tooth; suprahumerals weakly oblique, tips acute . . . . ***Spalirises** Distant

23(18). Suprahumerals horizontal, flat, rather long, acuminate; disk of pronotum robustly elevated posteriorly, angulate, then nearly straight, slender, acuminate, distant from the body, nearly long as tegmina . . . . ***Planecornua** Goding

24(13). Posterior process more or less curved from base, not angulate.

25(25). Inferior margin of posterior process ampliate or lobed at middle, usually nearly straight, moderately robust; suprahumerals variable †***Centrotus** Fabricius, *Beaufortiana* Distant

26(25). Inferior margin of posterior process not ampliate or lobed beneath.

27(30). Posterior process curved at base, then straight to apex.

28(29). Tegmina with two discoidal cells, not longer than abdomen; suprahumerals short, slender, horizontal, acuminate; posterior process slender, convexly elevated high above scutellum, then oblique and straight to apex.
***Tricoceps** Buckton, *Tambusa* Distant, *Tambusana* Distant

29(28). Tegmina with four discoidal cells, some longer than abdomen; suprahumerals oblique, tips obtuse or truncate; posterior process broad at base, slightly arched above scutellum, then straight to the apex . . . . ***Centrotusoides** Distant

30(27). Posterior process distinctly sinuate, not straight.

31(34). Posterior process moderately slender, strongly sinuate, acuminate at base.

32(33). Suprahumerals usually robust, strongly oblique †***Platybelus** Stal

33(32). Suprahumerals horizontal, slender, acuminate †***Evanchon** Goding

34(31). Posterior process heavy, not acuminate from base; suprahumerals very short, long as broad, thick, sides parallel, subhorizontal.

35(36). Posterior process with a large node at base, one at middle, and apical node ending in a spine even with but distant from tips of tegmina; suprahumerals serrate anteriorly, tips truncate emitting a spine; basal margin pronotum produced . ***Amitrochates** Distant

36(35). Posterior process not nodose, adjacent to tegmina behind clavus, apex abruptly attenuate, acute; surface spinose.
***Barsumas** Distant

Uroxiphini

KEY TO GENERA

1(8). Posterior process impinging upon the scutellum and margins of tegmina. (One species in *Pogontypus* it is slightly elevated).

2(7). Veins to apical cells of tegmina straight. (Rarely veins to the third and fourth apical cells irregularly slightly curved.)

3(6). Posterior process slender, gradually acuminate from base.

4(5). Base of posterior process much narrower than scutellum, apex slightly passing apex of clavus; pronotum convex, not gibbous, dorsum straight to apex; tegmina with two discoidal cells.
***Uroxiphus** Amyot and Serville

5(4). Base of posterior process a little narrower than scutellum, abruptly depressed and lightly sinuate, apical area strongly decurved almost to tips of tegmina; pronotum gibbous; tegmina usually with three discoidal cells . .. †**Dingkana** Goding

6(3). Posterior process thick and broad on basal half, sides parallel, slightly ampliated beneath, apical half abruptly slender, straight to apex of fifth apical cell of tegmina the latter with two discoidal cells . . †**Narnia** Walker, *Terentius* Stal

7(2). Veins to apical cells of tegmina strongly curved inwardly; pronotum convex, usually a short carina above each humeral, dorsum straight to apex; posterior process slender from base, much narrower than scutellum, tip just passing apex of clavus.
†**Pogontypus** Distant

8(1). Posterior process more or less distant from scutellum, slender.

9(14). Posterior process emitted from hind margin of pronotum, moderately sinuate, not strongly elevated above the scutellum.

10(13). Base of head destitute of tubercles; pronotum not gibbous; posterior process sometimes tricarinate.

11(12). Apical half of posterior process strongly curved upward equal to but distant from apex to clavus †**Occator** Distant

12(11). Apical third of posterior process straight, impinging upon margins of tegmina, tip slightly elevated just passing apex of clavus.
†***Melicharella** Goding, *Machærotypus* Melichar

13(10). Base of head with two prominent tubercles; pronotum convexly gibbous; posterior process moderately slender at base, slightly separated from scutellum, gradually acuminate, dorsum slightly sinuate, apical area straight tip far passing apex of clavus.
***Awania** Distant

14(9). Posterior process slender, tricarinate, emitted from high above hind margin of pronotum very distant from scutellum, straight, tip touching margins of tegmina far beyond apex of clavus; pronotum elevated, not gibbous . †**Demanga** Distant

Leptocentrini

KEY TO GENERA

1(22). *Base of posterior process distant from, rarely touching apex of scutellum.*

2(7). Basal area of posterior process nearly erect, then abruptly angulate and extended posteriorly.

3(4). Posterior process broadly compressed and convexly curved behind basal angle, apex briefly acute; suprahumerals long, broad, oblique, apical area curved outwardly, tips truncate.
***Xiphopœus** Stal, *Kleidos* Buckton

4(3). Posterior process straight and gradually acuminate beyond basal angle, tip acute.

5(6). Suprahumerals horizontal, triquetrous, medium; posterior process very robust on basal area, slender horizontal and acuminate beyond basal angle, often spinose on inferior margin; scutellum long as broad, apex emarginate.

***Euxiphopœus** Goding, *Xiphopœus* Stal, part

6(5). Suprahumerals strongly oblique, very long, slender, apical area curved, acute; posterior process slender from base, inferior margin not spinose; scutellum much longer than broad, apex acute.

†**Maarbarus**

7(2). Posterior process slender, curved or straight from base, not angulate near base.

8(13). Veins to apical cells of tegmina strongly curved inwardly.

9(10). Suprahumerals porrect, subparallel, apical area angulately extended outwardly; posterior process slightly arcuate from base; scutellum longer than broad, apex acute . . . . . †**Bathoutha**

10(9). Suprahumerals transversely horizontal or oblique, not porrect.

11(12). Scutellum long as broad, apex emarginate; posterior process sinuate its middle touching apex of scutellum, apical half impinging upon margins of tegmina; suprahumerals short, oblique, tips truncate . . . . †**Indicopleustes**

12(11). Scutellum much longer than broad, apex acute; posterior process straight from basal curve not touching margina of tegmina; suprahumerals horizontal, medium, slender, acute. . . . †**Parapogon** Distant

13(8). Veins to apical cells of tegmina straight.

14(21). Inferior margin of posterior process not lobed at middle, slender.

15(20). Scutellum about as long as broad, apex emarginate.

16(19). Disk or pronotum convexly elevated; suprahumerals transversely oblique, tips acute, not directed forwardly.

17(18). Posterior process convexly curved (straight in one species), extended far beyond apex of clavus.

*†**Leptocentrus** Stal, *Rabduchus* Buckton, *Boochar* Jacobi, part

18(17). Posterior process straight from base, obliquely elevated posteriorly and distant from margins of tegmina, apex not passing apex of clavus; suprahumerals short. . . . . †**Nilautama** Distant

19(16). Disk of pronotum not elevated; suprahumerals directed forwardly, subparallel, not distant, tips broadened and truncate; posterior process slender, tricarinate, long as tegmina. . . . †**Arimanes** Distant

20(15). Scutellum much longer than broad, apex acute; disk of pronotum not or slightly elevated, suprahumerals variable. . . **Telingana** Distant

21(14). Inferior margin of robust posterior process bearing a lobe or swelling touching apex of scutellum; suprahumerals nearly horizontal; tegmina with two or three discoidal cells.

†**Acanthophyes** Stal, *Lobocentrus* Stal, *Dograna* Distant

22(1). Base of posterior process touching or slightly separated from the scutellum, not distant from it.

23(24). Posterior process slightly but distinctly separated from the scutellum, shorter than tegmina.

24(29). Suprahumerals horizontal or subhorizontal.

25(28). Veins to apical cells of tegmina nearly straight, sometimes moderately oblique.

26(27). Posterior process broadly compressed beyond apex of scutellum, then laterally globose, apical area abruptly narrowed and depressed on margins of tegmina; suprahumerals slender, acute. †**Aspasiana** Distant

27(26). Posterior process moderately narrow, undulate; sides straight, apical area impinging upon margins of tegmina; suprahumerals medium; tegmina slightly longer than abdomen *__Tshaka__ Distant

28(25). Veins to apical cells of tegmina curved inwardly; suprahumerals very short, acute, posterior process slender . †**Polonius** Distant

30(33). Posterior process strongly undulate or sinuate, suprahumerals short; pronotum gibbous.

31(32). Front of pronotum moderately crescentiform and continuous with acute suprahumerals; posterior process medium, undulate. *__Dacaratha__ Distant

32(31). Front of pronotum not crescentiform; posterior process sinuate, tips of suprahumerals obtuse . . †**Imporcitor** Distant

33(30). Posterior process slender, slightly sinuate; pronotum not gibbous, suprahumerals acute, rarely inclined forward *†**Otinotus** Buckton

34(23). Posterior process impinging upon and sometimes nearly covering the scutellum.

35(44). Suprahumerals inclined forward, with numerous carinæ, or reticulate.

36(41). Suprahumerals strongly oblique or suberect, posterior process straight, apical area decurved.

37(40). Posterior process at least as long as the tegmina.

38(39). Suprahumerals long, robust, compressed, tips truncate or bidentate; apical half of posterior process strongly decurved, tip obtuse; tegmina usually with three discoidal cells. †**Eufrenchia** Goding, *Ibiceps* Buckton

39(38). Suprahumerals medium, triquetrous, gradually narrowed, tips obliquely truncate and subacute; apical area of posterior process lightly decurved, subacute; tegmina with two discoidal cells. †**Cebes** Distant

40(37). Posterior process straight, much shorter than tegmina, suprahumerals long, compressed, reticulate, apical area dilated, tips rounded the inner angles contiguous or approaching, the outer angle a short spine; tegmina with two discoidal cells. †**Lubra** Goding

41(36). Suprahumerals porrect, broad, compressed, slightly diverging, tricarinate the posterior carina continued on posterior process to tip, bases distant, tips obtuse; posterior process straight, at least as long as tegmina, tip elevated . . . . †**Sarantus** Stal

42(35). Suprahumerals transversely oblique or horizontal, not inclined forward. They are inclined forward in one species each in *Sextius* and *Acanthuchus* and two in *Otinotus*.

43(46). Posterior process as long or longer than tegmina, rarely very slightly shorter, moderately sinuate. It is as long as tegmina in two species each in *Sextius* and *Acanthuchus*. Suprahumerals more or less oblique, rarely subhorizontal, tips acute.

44(45). Pronotum very strongly rugose, irregularly carinate, outer carina of suprahumerals continuous with lateral carina of the moderately slender posterior process . †**Godingella** Distant

45(44). Pronotum not rugose or irregularly carinate; posterior process robust at base, gradually acuminate, apical area convexly curved, slender, short carina each side of base sometimes continued posteriorly:

a. Corium with five apical cells †**Otinotoides** Distant

aa. Corium with three apical cells †*Gondopharnes* Distant

46(43). Posterior process distinctly shorter than the tegmina.

47(50). Suprahumerals long, broad, erect or suberect.

48(49). Suprahumerals erect, laminate, tips broadly rounded hind angle acute, posterior process broad, acuminte, tip subacute.
†**Elegius** Distant

49(48). Suprahumerals suberect, some diverging, triquetrous at base, compressed upwardly antero-posteriorly, twisted, tips distinctly broadened, truncate; posterior process heavy, acuminate tip decurved.
†**Ceraon** Buckton, *Daunus* Stal, *Zanophara* Kirkaldy

50(47). Suprahumerals horizontal or broadly oblique.

51(58). Suprahumerals horizontal or subhorizontal.

52(55). Pronotum more or less gibbous before base of posterior process, suprahumerals very short, acute.

53(54). Pronotum strongly gibbous before base of posterior process, suprahumerals in a continuous line with the crescentic anterior area, seen from the front convex laterally; suprahumerals robust, recurved, subacute, posterior process, robust, nearly straight, beyond base . . . . †**Emphusis** Buckton

54(53). Pronotum moderately gibbous before base of posterior process, not crescentiform anteriorly; suprahumerals slender, straight, acute; posterior process slender, sinuate, tip decurved . . . . . . †**Crito** Distant

55(52). Pronotum not gibbous before base of posterior process, dorsum of posterior process about even with disk or pronotum.

56(57). Median carina of pronotum elevated just beyond base of suprahumerals in a spine or angle, or briefly foliaceous, rarely a second

elevation near middle of posterior process; sometimes one or two veins to apical cells slightly sinuate †**Acanthuchus** Stal

57(56). Dorsum of pronotum nearly level from apex of metopidium to apex of posterior process, not dentate or foliaceous, the latter slightly ampliated near base, nearly straight, tip acute. †**Sertorius** Stal

58(51). Suprahumerals more or less strongly oblique.

59(68). Veins to apical cells of corium straight, rarely one or two veins slightly sinuate.

60(67). Dorsum nearly straight, not gibbous anteriorly.

61(66). Suprahumerals robust, weakly oblique, slightly elevated.

62(65). Apical area of corium normal, not reticulate.

63(64). Distance between bases of suprahumerals equal to width of head; suprahumerals triquetrous, tips subacute, dorsum of posterior process slightly arcuate; apical cells of corium moderately short and broad *†**Centruchus** Stal, *Leucothorax* Buckton

64(63). Distance between bases of suprahumerals shorter than width of head; suprahumerals compressed, upper surface multicarinate, tips roundly truncate rarely acute; dorsum of posterior process usually straight; apical cells of corium elongate †**Eufairmairia** Distant

65(62). Apical area of corium strongly reticulate with numerous venules; tips of suprahumerals subacute. †**Sextius** Stal, *Pterosticta* Buckton

66(62). Suprahumerals slender, distinctly oblique, longer than space between bases, acute; posterior process slender; dorsum level. †**Periaman** Distant

67(60). Pronotum more or less gibbous; posterior process robust, shorter than tegmina, suprahumerals broad, curved upwardly, tips acute. †**Centrotypus** Stal, *Ibiceps* Distant, *Lestarches* Distant

68(59). Veins to apical cells of corium strongly curved inwardly, first apical cell very long; suprahumerals not longer than intervening space sometimes much shorter and weakly oblique, tips acute, recurved; posterior process slender, shorter than tegmina, slightly elevated at base in one species †**Pogon** Buckton

Micreunini

KEY TO GENERA

1(4). Posterior process emitted from near the hind margin of pronotum but slightly separated from the scutellum; summit of the front process with a slender spine each side; apex of clavus obtuse.

2(3). Front process slightly inclined forward, slender, the summit not expanded; lateral spines of summit long, slender, recurved, tricarinate; posterior process slender, lightly arched to middle of abdomen . . . . †**Micruene** Walker

3(2). Front process erect its summit broadly dilated laterally, lateral spines short, bigibbous behind; posterior process sinuate, about as long as but not touching margins of tegmina.

†**Eutryonia** Goding, *Gelastorrhachis* Kilkaldy

4(1). Posterior process long, linear, straight or slightly convex, emitted from hind margin of front process at or below the summit, distant from the scutellum, apex approaching margins of tegmina; summit of front process emitting a long slender branch each side; apex of clavus obtuse.

5(6). Lateral branches at summit of front process moderately long, linear, recurved; posterior process just passing clavus.

†**Leptobelus** Stal

6(5). Lateral branches at summit of front process long, not linear, slightly recurved the apical half downward, emitting from its middle a strong spine projecting forward; posterior process nearly as long as tegmina .... †**Elaphiceps** Buckton

Hypsauchenini

KEY TO GENERA

1(12). Posterior process impinging upon the scutellum and inner margins of tegmina the latter usually with three discoidal and five apical cells, the apex of clavus acute.

2(9). Dorsal margin of posterior process with a subapical node; legs simple.

3(4). Apex of head trilobed; front process strongly and lengthily recurved, anterior lateral carinæ not extended below to base, its summit bilobed not extended beyond apex of posterior process.

†**Hypsauchenia** Germar

4(3). Apex of head spatulate.

5(8). Front process strongly lengthily recurved its summit bilobed; venation of tegmina normal or nearly so.

6(7). Apical margin of tegmina obliquely truncate, apical angle acute; anterior lateral carinæ of front process extended to base its summit not extended beyond apex of posterior process; head with a central keel; size smaller.

†**Pyrgauchenia** Breddin, *Pyrgophyllium* Breddin, *Pyrgolyrium* Breddin, *Hypsophyllium* Schmidt

7(6). Apical margin of tegmina obtusely rounded; anterior lateral carinæ abbreviated before base its summit extended half its length beyond apex of posterior process; head not keeled, a deep sulcus near base; size large .... †**Gigantorhabdus** Schmidt

8(5). Front process straight, nearly erect, lightly inclined forward, broad, compressed, anterior lateral carinæ not extended below its base, summit rounded produced in a hooked spine behind with a nodule just beneath; or briefly bilobed; apical area of tegmina multicel-

lular, apical margin obliquely truncate, apical angle acute; size medium .... †**Hypsolyrium** Schmidt

9(2). Dorsum of posterior process nearly straight without a subapical node.

10(11). Front process long, recurved, erect or inclined forward, moderately slender, compressed, sometimes nodulate or bulb at middle, the summit nodular, bulbous or bifurcate.
†**Pyrgonota** Stal, *Hybanda* Dist. *Funkhouserella* Schmidt

11(10). Front process distinctly porrect, short, compressed, summit obtuse; base of pronotum projecting forward; first apical cell of wings minute, ovate, sinuate before the second apical cell (unusual); head with two tubercles near base, apex spatulate; ocelli nearer to eyes .... †**Hybandoides** Distant, *Platyceras* Schmidt

12(1). Posterior process slender, erect for a space then angulate (as in *Anchon*) and straight, shorter than tegmina; front process nearly erect slightly inclined forward, gradually narrowed to the bilobed summit; tegmina with two discoidal and five apical cells, apical angle subacute, apex of clavus obtuse; clypeus long, narrow, tip obtuse; ocelli equidistant .... ***Congellana** Distant

Centrocharesini

KEY TO GENERA

1(4). Dorsum of posterior process with a basal and subapical node; suprahumerals erect or lightly recurved; pronotum more or less spinulose or nodulate.

2(3). Apex of clavus acute; posterior process slightly elevated at base fully exposing scutellum, then impinging upon and extended to tips of tegmina which have two discoidal cells .... †**Centrochares** Stal

3(2). Apex of clavus obtuse; posterior process impinging upon scutellum whose narrow sides are visible, apical area elevated and extended midway between apex of clavus and tips of but no touching tegmina, the latter with three discoidal cells .... ***Negus** Jacobi

4(1). Posterior process tricarinate, far passing apex of clavus, dorsum straight, destitute of nodes; suprahumerals lightly inclined forwardly; pronotum rugosely carinate and nodulose, not spinulose, sides of chest with two teeth each side; tegmina with two discoidal and five apical cells, tips acute without a limbus. Type, *Daunus gracilis* Goding, (♀), in Mon, Aust. Memb. p. 33. (1903), from Beverly, West Australia .... †**Sinenodus** gen. nov.

MEMBRACINÆ

KEY TO TRIBES

1(4). Wings with four apical cells; tegmina with at least three discoidal and five apical cells sides of chest with one or two teeth, apex of clavus obtuse.

2(3). Pronotum elevated in a nearly erect robust process its summit with a strong bulbous protuberance each side and posteriorly; dorsum of posterior process elevated in a foliaceous or tectiform plate; the surface is reticulate with raised lines .. . *Bolbauchenini*

3(2). Pronotum cornute or with a short carina or small tubercle above each humeral; dorsum of posterior process nearly straight or nodose, apex not compresso-ampliate beneath, usually not elevated. *Xiphistesini*

4(1). Wings with three apical cells; tegmina with three discoidal and five apical cells, apex of clavus obtuse; pronotum cornute or unarmed above each humeral, suprahumerals erect or porrect; posterior process tricarinate, dorsum usually concave, apical area compresso-ampliate beneath and elevated; sides of chest with one or two teeth . .. *Oxyrhachisini*

Bolbauchenini

KEY TO GENERA

One genus is at present known; the characters are as given in the description of the Tribe.

†**Bolbauchenia** Schumacher, *Clonauchenia* Funkhouser

Xiphistesini

KEY TO GENERA

1(2). Dorsum of posterior process binodose.
*__Gongroneura__ Jacobi, *Pedalion* Buckton

2(1). Dorsum of posterior process nearly straight, rarely a small gibba at base.

3(4). Apical area of tegmina multicellular; suprahumerals robust, porrect, tips truncate; posterior process about long as tegmina dorsum convex . .. . †**Goddefroyinella** Distant

4(3). Venation of tegmina normal.

5(6). Pronotum unarmed, sometimes with a short carina above each humeral .... *__Xiphidia__ Goding

6(5). Pronotum cornute above each humeral.
*†**Xiphistes** Stal, *Neoxiphistes* Distant

Oxyrhachisini

KEY TO GENERA

1(2). Pronotum unarmed, a short carina or tubercle above each humeral.
†**Oxyrhachidia** Melichar

2(1). Pronotum cornute above each humeral.
*†**Oxyrhachis** Germar, *Polocentrus* Buckton, *Ouranorthus* Buckton

DARNINÆ

KEY TO TRIBES

1(2). Pronotum unarmed above humerals .. . . *Darnini*

2(1). Pronotum cornute above each humeral .... *Hemikypthini*

Darnini

KEY TO GENERA

1(4). Wings with three apical cells; pronotum gradually passing into posterior process, dorsal line nearly straight.

2(3). Clavus with apex obliquely obtuse; tegmina with two discoidal and five apical cells . †**Cryptaspidia** Stal

3(2). Clavus acuminate apex acute; apical area of tegmina multicellular. †**Anzac** Distant

4(1). Wings with four apical cells; tegmina with three discoidal and five apical cells, apex of clavus acute; disk of pronotum elevated in a triangular pyramidal crest †**Mesocentrus** Funkhouser

Hemikypthini

KEY TO GENERA

1(2). Suprahumerals long, strongly oblique, broad between bases, margins parallel and carinate, tips squarely truncate; posterior process broad at base, gradually acuminate, long as abdomen. †**Megaloschema** Buckton

2(1). Suprahumerals short, slender, oblique, recurved, tips acute; posterior process long, slender, tricarinate, straight, about long as abdomen; tegmina subhyaline, with two discoidal and five apical cells; legs simple. Type, *Centrotypus parvus* Funkhouser, Rec. Indian Mus. xxiv, p. 325, pl. 10, fig. 2, (1922), from Perak, Malay Peninsula, East Indies †**Cryptoparma** gen. nov.

ANTHIDIUM POLINGÆ, NEW SPECIES, FROM TEXAS

BY HERBERT F. SCHWARZ

♀. Head a little broader than long and immaculate except for a cream-colored oval spot above each eye. The mandibles sexdentate, the outer tooth the largest and longest. The clypeus convex and prominent, slightly emarginate and crenulate to subdentate along the middle of its apex; two teeth on each side of its apex, of which the inner tooth is the more prominent. The clypeus and adjacent sides of the face densely and coarsely punctated; the front and vertex densely but less coarsely punctated, the punctures being of smaller size than those of the clypeus. The upslanting hairs of the front and those fringing the scape of a more luminous and brighter gray in certain lights than the rather dull, downslanting gray hairs of the lower half of the face and of the cheeks. The hair of the vertex ochraceous to faintly golden; the hairs fringing the apex of the clypeus copper-tinged.

The mesontum with hair of hue identical with that of the vertex. The hair on the pleura gray, of a tinge approximating that of the hair on the lower half of the face. The mesonotum and scutellum densely and rather evenly punctated, the punctures slightly larger than those on the vertex but smaller than those on the clypeus. The mesopleura densely punctated, the density and size of the punctures much like those of the mesonotum. The basal part of the triangular enclosure of the propodeum broadly covered with small punctures that are arranged more or less chainlike on a feebly tesselated surface. The apical part of the triangular enclosure devoid of punctation, feebly, almost negligibly tesselated, verging on the smooth. An abbreviated cream-colored linear maculation along each side of the anterior margin of the mesonotum separated from the antero-lateral angle of the mesonotum by its own length or less; usually also a linear maculation of feebler development and of more restricted length on each of the lateral margins of the mesonotum just above the tegulæ; the tegulæ cream-colored except for a large brownish pupil; the tubercles cream-colored; and four cream-colored spots (not confluent) arranged in a semicircle along the posterior half of the axillæ and scutellum.

The legs for the most part (coxæ, trochanters, femora, tibiæ) with gray hairs similar to those on the face and pleura. Densely matted, felt-like patches of white hair on the antero-basal half or two-thirds of the front and middle basitarsi externally and over most of the external surface of the hind basitarsi. These white patches are in sharp contrast to the black hairs on the postero-apical half or third of the front and middle basitarsi, along the anterior margin of the hind basitarsi and on the under side of all the

basitarsi. The lower tarsal joints with mostly black hair, occasionally partly replaced by silvery hairs, especially on the hind pair of legs. The tarsal claws largely dark red, verging on black throughout—only in a few of the specimens is the basal portion of the claws of a well differentiated, lighter hue than the apical portion. The tibial spines of the hind leg are black. There is a cream-colored linear maculation of variable length on all of the tibiæ, in some instances extending far down the joint (particularly is this true in the case of the hind and sometimes the front tibiæ), in other instances confined to the base.

The wings are hyaline, the nervures dark; a brown streak traverses the marginal cell from its base almost to the apex.

The tergites of the abdomen rather sparsely punctured, the punctures a little denser toward the side as contrasted with the middle of each tergite and denser on the apical tergite than on those preceding. The punctures tend to arrange themselves in irregular chains. On the apical rims of the tergites the punctures are distinctly smaller, denser, and more clearly defined than on the basal part of the tergites, but even here the density is less than is the case in most of the other species, smooth spaces frequently intervening between the more or less chainlike groupings. Gray hairs cover the first five tergites rather uniformly if sparsely. On the apical tergite (sometimes also the penultimate) these gray hairs are often largely or wholly replaced by black, and the dense ventral scopa is pitch black. Tergites 1–5 with cream-colored maculations, tergite 6 usually entirely black but sometimes (2 out of 9 instances before me) with two feeble maculations. Tergite 1 usually four-spotted, the inner maculations linear to cuneiform and smaller than the outer ones, which have a slight emargination on their inner side. The maculations on tergites 2–4 consist of two clearly and rather widely separated halves each of which is deeply and broadly emarginate above, resulting in club-like extremities connected by a narrow band. In the case of tergite 2, the outer clavate elements are the larger, the inner clavate elements the smaller. In the case of tergite 3 (usually) and tergite 4 this condition is reversed, and sometimes on tergite 4 the outer elements are even lacking, merely two inner spots surviving. What is exceptional for tergite 4 is the rule for tergite 5. The apical contour of tergite 6, viewed from above is devoid of toothlike interruptions. There is a shoulderlike rounding of the surface on each side of the tergite. The apex of the tergite is broadly subtruncate with a little notch in the center, where the sting emerges.

♂. The entire clypeus, except for its medianly somewhat deeply and broadly emarginate apex, which when viewed from above seems rimmed with brown, is uniformly cream-colored as are the cuneiform marks that fill the spaces between the clypeus and the eye to the level of the antennæ. Also cream-colored are the mandibles except for their tridentate apical extremity, a stripe (sometimes feebly developed) on the scape in front, and an oval spot above each eye. The hair on the face both above and below the antennæ and fringing the scape is abundant and of a glistening white.

The upper contour of this hirsute area is sharply defined at the level of the ocelli, with a V-shaped emargination at its middle where the anterior ocellus cuts in. The hairs of the vertex, as in the female, incline to light yellowish or pale golden.

The sculpture, color of the hair, and maculations of the thorax like those of the female except that the maculations on the anterior margin of the mesonotum are more developed and the maculations on the axillæ are diminutive (in one specimen even lacking).

The dense felt-like patches of white hair present on the basitarsi of the female are replaced in the male by longer, sparser, silvery hairs and the contrasting hairs of black are confined largely to the underside of the basitarsi. The front femora sometimes with a cream-colored posterior spot near the apex; a stripe of similar color along the exterior of the front tibiæ, nearly attaining the apex; the middle tibiæ usually with a stripe running externally from base to apex (sometimes medianly interrupted); the hind tibiæ with a more or less extended linear maculation at the base; all of the basitarsi externally with a pale stripe of usually feeble development.

Tergite 1 maculated in a manner rather similar to that of the female, with four widely separated spots—the outer ones large, the inner ones small. The subsequent tergites with a band that is medianly widely sundered, as in the female. The resulting halves with a deep, rather wide, subrectangular emargination above. So deep are these emarginations on tergite 2 (and sometimes also on tergite 3) that a four-spotted condition results. On tergites 2–3, as on tergite 1, the outer elements of the maculation are larger than the inner; on tergite 4 inner and outer elements are subequal; on tergite 5 the inner elements are the more developed; on tergite 6 there are two large inner spots, sometimes more or less comma-like. The pygidium has a spot of variable extent on each of its lateral lobes. The pygidium rather unstable also in shape, the lateral lobes of variable width from specimen to specimen, but in all cases narrower at the level of the apex of the central spine than the distance separating the inner contour of each at this level from the spine. The curvature of this inner contour is gradual and regular, without angulation, so that, if the central spine be disregarded, the shape approximates that of a semi-circle. The outer apical contour of the lobes is, on the other hand, at more or less of an angle with the outer basal part. The central spine extends only about half as far as the lateral lobes. The range of variability of the pygidium is shown in Plate XIX, Fig. 1 (type) and Fig. 2 (a paratype). The spines on each side of segment 6 are straight, not incurved and hook-like. The hair on the abdomen of the male, in contrast to that of the female, is wholly or predominantly silvery both below and above, only one of the three specimens having a very slight admixture of dark hairs on the under side of the abdomen. The last visible sternite (Fig. 5 of Plate XIX) largely black, with an obtuse faint angulation on each side of the apex and a ferruginous and triangular extension (slightly emarginate at the tip) at the middle of the apex. There is a short, longitudinal, shiny, almost tubercle-like carina at

the middle of the base of this sternite and a polished area extends broadly from it almost to the apex of the median extension.

The female of this species is one of the few representatives of *Anthidium* in North America that has exclusively black ventral scopa. Eliminating species like *tenuifloræ*, in which the scopa is occasionally sepia-colored, the following key may be of service in differentiating females of *polingæ* from those of other species that also have dark scopa either regularly or exceptionally.

KEY TO FEMALES WITH DARK SCOPA

1. The clypeus or the adjacent parts of the sides of the face, almost invariably both, with yellow. The bands on tergites 2–4 continuous, being merely notched at the middle and more or less sinuously emarginate above on the sides. Tergite 6 heavily and continuously maculated. The ventral scopa not always dark, frequently with light bordering hairs, and sometimes all but replaced by light hairs *aridum*

   The clypeus and the adjacent parts of the sides of the face black. The maculations on tergite 2–4, when band-like, usually with a distinct if narrow median separation. Tergite 6 two-spotted or immaculate 2

2. The tibiæ immaculate. Tergite 5 as well as 6 immaculate . *atripes*

   The tibiæ with at least basal spots. Tergite 5 and sometimes 6 with maculations 3

3. Robust, 10–12 mm. Median interruption on abdominal bands wide. Tergite 1 four-spotted; tergite 6 more often immaculate *polingæ*

   Slender, 7–9 mm. Median interruption on abdominal bands narrow. Tergite 1 with a medianly interrupted band, the lateral halves sometimes enclosing a black dot; tergite 6 more often maculated. *atriventre* (*astragali*)

Although the female of *polingæ* seems in many ways close to that of *atriventre*, the male of *polingæ* differs structurally from that of the related species. The lobes of the pygidium, although variable, are much more slender than those of *atriventre*, in the most extreme case (the type—see Fig. 1 of Plate XIX) approximating the condition represented by *palliventre* (*californicum*). Another, even more marked structural difference is in the apical process on the last visible sternite. The lateral elements of this process are in *polingæ* (Fig. 5 of Plate XIX) very obtusely triangular; in *atriventre* (Fig. 4 of Plate XIX) they are acutely triangular and at their termination rather spine-like. Superficially the male of *polingæ* is at once separable from that of *atriventre* by its greater size and by the medianly widely separated bands on tergites 2–5; in *atriventre* the bands on these

segments are merely emarginate medianly. The same characters make possible the separation of the male of *polingæ* also from *aridum*, with which species its relationship is at best remote. Probably its closest relative is *atripes*, but the male of *polingæ* is readily differentiated from the male of *atripes* among other characters by the presence of developed maculations on its legs, by the presence of pale pile instead of black, and by the fuller maculation of its abdomen, the maculations of *atripes* not extending beyond tergite 5. The apex of the clypeus of the males of both *atripes* and *polingæ* has a rather strong curvilinear emargination medianly, and the punctures on the apical rims of the tergites are not so crowded as in many other species and have a tendency to arrange themselves in chainlike groupings.

The above descriptions are based on 11 females and 3 males, all collected by Mrs. O. C. Poling, after whom the species is named. The specimens all bear the same data: "Ft. Davis, Texas, Jeff Davis Co., 5000 ft., Davis Mts., July–Aug. '27 and '28." They were submitted to me through the courtesy of Professor H. A. Scullen, of Oregon State Agricultural College, to whom the holotype, allotype, and eight paratypes have been returned. The remaining four paratypes are in the American Museum. The figures of the plate accompanying the description have been prepared by Mrs. E. L. Beutenmüller.

PLATE XIX

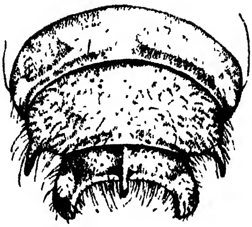
Figure 1. Dorsal aspect of the apical part of the abdomen of *Anthidium polingæ*, with special reference to the structure of the pygidium. (Type specimen.)

Figure 2. Dorsal aspect of the apical part of the abdomen of one of the paratypes of *Anthidium polingæ*, showing the extreme width of the variable lateral lobes of the pygidium.

Figure 3. Genitalia of *Anthidium polingæ*. A composite drawing based on the three male specimens.

Figure 4. Ventral aspect of the apical part of the abdomen of *Anthidium atriventre* after removal of the genitalia, with special reference to the rather spinelike lateral processes on the last visible sternite.

Figure 5. Ventral aspect of the apical part of the abdomen of *Anthidium polingi*, showing the much less angular lateral processes on the last visible sternite. The genitalia had previously been removed.



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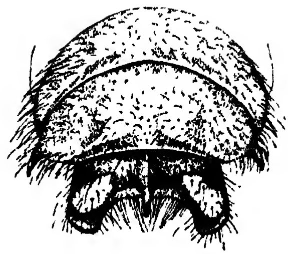

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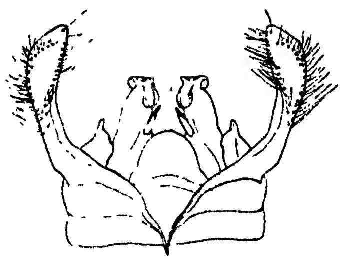

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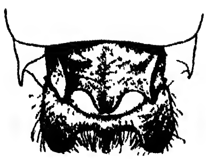

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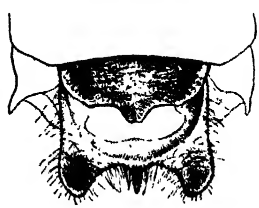

5.

ANTHIDIUM

A PHYLOGENETIC STUDY OF THE POSTERIOR METATHORACIC AND BASAL ABDOMINAL STRUCTURES OF INSECTS, WITH PARTICULAR REFERENCE TO THE HOLOMETABOLA

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In order to test the evidence of the relationships of insects, from as widely divergent sources as possible, such markedly different and widely separated structures as the maxillæ, the neck and prothoracic sclerites, and the terminal abdominal structures of female insects, have been compared throughout all of the orders of living insects (see Crampton, 1923, 1926 and 1929); and to the evidence from these sources may be added that furnished by the study of yet another portion of the body, namely, the posterior metathoracic and basal abdominal regions.

Of the lower insects studied, only the blattids, Isoptera, Dermaptera, leaping Orthoptera (*Rhipipteryx*) and psocids (*Zorotypus*) have been included at this time, since it would require too many plates to figure all of the lower types, in addition to the five plates of figures of the Holometabolous forms here described! The discussion of the other lower pterygotan and apterygotan insects will be taken up in another paper dealing with the more important representatives of these insects.

For the greater part of the material used in the preparation of the present paper, I am deeply indebted to Messrs. C. P. Alexander, C. T. Brues, J. W. Campbell, C. H. Curran, E. Hearle, A. D. Imms, R. J. Tillyard and W. M. Wheeler. To all of these gentlemen I would express my deep appreciation of the aid they have so kindly given.

In discussing the interrelationships of the Holometabola, we may begin with the consideration of the fleas, or Siphonaptera, since the systematic position of these insects is still a matter of dispute, and such evidence as I have been able to gather indicates quite definitely that the fleas could not possibly be derived

from either the Diptera or the Coleoptera, which are the two groups suggested as the precursors of the fleas by most recent investigators. On page 487 of the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, Vol. XXXVII, for 1929, I have summarized the evidence indicating that fleas could not be derived from Diptera or Coleoptera—for the following reasons. The labial palpi of fleas are frequently composed of at least three segments, while the labial palpi of Diptera (labella) and Mecoptera are never composed of more than two segments, and therefore could not serve as the prototypes of the labial palpi of fleas. The metathorax and mesothorax are subequal in fleas, and this condition could not be derived from the dipterous one in which the metathorax is strikingly smaller than the mesothorax (the metathorax of a typical diptron is only a fraction of the size of the mesothorax). The metathoracic coxa is divided into a eucoxa (anterior region) and meron (posterior region) in fleas, and this condition could not be derived from that exhibited by the Diptera, which have no meron in the metathoracic leg.

The mesothoracic and metathoracic coxæ are divided into a eucoxa and meron in fleas, while in the Coleoptera there is no such division of the mesothoracic coxa, and the Coleoptera therefore could not serve as the precursors of the fleas. Fleas apparently have cerci, whereas no known Coleoptera have cerci, so that on this basis also, the Coleoptera could not serve as the types ancestral to the fleas. On the other hand, it was pointed out in the publication cited above, that the Trichoptera could readily serve as the types ancestral to fleas since they have three-segmented labial palpi, their prothoracic sclerites are as much like those of the fleas as any insects, the mesothoracic and metathoracic coxæ of Trichoptera are divided into a eucoxa and meron, and the Trichoptera have cerci and terminal structures suggestive of those of the fleas.

The evidence furnished by a study of the metathoracic structures of fleas is so overwhelmingly convincing and may be so readily seen and appreciated by any one who is willing to give it a moment's attention, that it is indeed astonishing that no one has been willing to consider these structures in attempting to determine the affinities of the Siphonaptera. Any one who will

examine a common dog flea (Fig. 1) can readily see that its mesothorax and metathorax are subequal, while in any dipteron (Fig. 13) the metathorax is only a fraction of the size of the immensely developed mesothorax. Unless we completely reject Dollo's law of the irreversibility of evolution, we must assume that the ancestors of the fleas likewise had a mesothorax and metathorax subequal in size, and this would utterly preclude deriving fleas from Diptera, all of which (including the Phorids) have the metathorax reduced to a mere fraction of the size of the mesothorax. All of the fleas which I have examined have a metathoracic coxa divided into a eucoxa, or anterior region *ec* of Fig 1 and a meron, or posterior region *me* of Fig. 1 and this is apparently typical of fleas in general, so that it was evidently a prominent feature in their ancestors. No known Diptera (not even phorids, etc.), however, have a well-developed meron in the posterior leg (see Figs. 9, 12, 13, 14, etc.), and such Mecoptera as *Boreus* shown in Fig. 6 (considered by Tillyard to represent a type ancestral to the Siphonaptera) likewise lack a well-developed meron in the metathoracic leg (although other Mecoptera have it quite well developed) so that the evidence from this source is in harmony with that furnished by the labial palpi and other structures indicating that the fleas could not be derived from the Diptera, or from such Mecoptera as *Boreus*.

When we compare the metathoracic structures of a typical flea such as the one shown in Fig. 1, with those of a parasitic coleopteron such as *Platypsylla*, shown in Fig. 3 (supposedly representing a type ancestral to the fleas, according to those who maintain that fleas were descended from coleopterous forebears or with the structures of any other Coleoptera, such as the ones shown in Figs. 26, 27, 34, etc., it is at once apparent that the suture between the episternum (es) and epimeron (em) is vertical in the flea, while in the Coleoptera under consideration, the metathoracic pleural suture (i.e., the suture between the episternum and epimeron) is more nearly horizontal. The ancestors of the fleas must have had a more nearly vertical pleural suture in the metathoracic region, and this would exclude from consideration such forms as the Hymenoptera and Coleoptera (which have a more oblique metapleural suture) in attempting

to determine the character of the ancestors of the Siphonaptera. Furthermore, the Hymenoptera and Coleoptera do not have a well-developed meron in the mesothorax, as the fleas do, and in the metathorax also, the meron is not typically developed in the Coleoptera and Hymenoptera (see Figs. 26, 27, 34, 18, 21, 22, etc.) while it is characteristic of fleas to have a well developed meron (*me* of Fig. 1) in the metathoracic leg, and the same must have been characteristic of their ancestors. Furthermore, the line of union between the metathoracic trochanter and femur tends to extend obliquely downward in the Coleoptera (Figs. 3 and 27) while in the fleas, the line of union between the trochanter and femur is not of this type—in fact the line of union is more "transeverse" or may even tend to slant in the other direction (i.e., "upward") in the fleas. The metathorax is usually much larger than the mesothorax in the Coleoptera, while in the fleas, and probably in their ancestors also, the mesothorax tends to be of approximately the same size as the metathorax. In the Coleoptera the meso- and metathoracic sternal regions do not become narrowed and extend posteriorly between the legs and give off lateral extensions furnishing secondary points of articulation along the mesal surface of the legs, while in the fleas and probably also in their ancestors, the sternal region becomes extremely narrow between the legs and a lateral "wing" or extension of the sternal region (like that present in Trichoptera, etc.), is produced along the mesal surface of the leg (such an extension is shown in the mesothoracic region of the flea shown in Fig. 1—i.e., the structure labelled *le* in Fig. 1). All of these facts are in harmony with the conclusions reached from the study of other structures as well (e.g., the character of the terminal abdominal structures) indicating that fleas could not be derived from the Coleoptera, and for essentially the same reasons, the fleas could not be derived from the Hymenoptera either.

Since the evidence afforded by the structures thus far studied eliminates the Diptera, Coleoptera (with the Strepsiptera), Hymenoptera and such Mecoptera as *Boreus* from consideration as possible ancestors of the Siphonaptera, this leaves only the Trichoptera, Lepidoptera, Neuroptera and certain Mecoptera to

be considered in this connection (the character of the larval fleas indicates that the group is a Holometabolous one, and their ancestors must therefore have been Holometabola of some sort) and greatly simplifies the problem of determining the probable ancestors of the fleas.

The metathoracic meron *me* of the flea shown in Fig. 1 is rather suggestive of that of the lepidopteron shown in Fig. 2, and the metathoracic pleural suture ps is more vertical in both of these insects. The lepidopteron shown in Fig. 2, however, belongs to an order descended from Trichoptera-like forebears, and such resemblances as these might be due to the fact that both the fleas and Lepidoptera were descended from Trichoptera-like forebears. Furthermore, the Trichoptera are closely related to the mecopteroid forebears of the Diptera, and are the intermediate forms combining in themselves not only lepidopterous characters, but also many features occurring in the Mecoptera and their dipterous descendants, and any resemblances between the fleas and the Lepidoptera, on the one hand, or between the fleas and the dipterous descendants of the Mecoptera on the other, could be readily explained by their common relationship to the Trichoptera, which are intermediate forms related to the Lepidoptera and also to the Mecoptera and Diptera.

So far as their larvæ are concerned, fleas resemble the Diptera in many respects, especially in their legless condition, and in the development of their setæ; but in the structural details of the head capsule and mouthparts which are practically the only structures in larval fleas sufficiently well developed for comparison with other insects, the resemblance of flea larvæ to the larvæ of Trichoptera is even more marked, and such resemblances as are to be found in dipterous and siphonapterous larvæ may possibly be explained as the results of their mutual relationship to the Trichoptera. In fact, as I have pointed out on page 241 of the Brooklyn Entomological Society, Vol. XXV, for 1930, a study of the structural details of such primitive dipterous larvæ as those of the Tanyderidæ and Bibionidæ very clearly, indicates that the larvæ of the ancestral Diptera were like those of the Trichoptera as well as the Mecoptera, since these primitive dipterous larvæ resemble trichopterous larvæ quite as much as they

do the larvæ of the Mecoptera in their structural details, and since both Diptera and Siphonaptera resemble the Trichoptera in their larval stages, it is not surprising that larval Diptera and Siphonaptera resemble each other as well.

The larvæ of the higher Neuroptera such as the Planipennia, typically have the mandibles, etc., extremely elongated and sickle-shaped, and are quite unlike flea larvæ in this respect, while the larvæ of the lower Neuroptera have well developed thoracic legs and primitive head structures altogether different from those of flea larvæ, and the adult structures are likewise quite different from those of typical fleas, so that it is not very probable that fleas were derived from such primitive forms as the Neuroptera themselves, and the Mecoptera (ancestral to the Diptera) and the Trichoptera, with their offshoots, the Lepidoptera, furnish more promising material for attempting to reconstruct the types ancestral to the Siphonaptera.

As far as the meso- and metathoracic structures are concerned, adult Mecoptera could serve quite as well as the Trichoptera as the types ancestral to the fleas; but, as I have pointed out elsewhere (Crampton, 1925), the character of the labium of a typical flea, with its three-segmented labial palpi, distinct, well sclerotized submentum, etc., precludes our deriving fleas from Mecoptera, all of which have a labium with but two segments in the palpi, and the labium of all Mecoptera lacks the submental plate, etc., so that on this account we must seek for the ancestors of the fleas in some other type of Holometabola. This, then, leaves only the Lepidoptera and Trichoptera among the forms not excluded by some important anatomical features from serving as the prototypes of the Siphonaptera.

The Lepidoptera furnish extremely promising material for reconstructing the types ancestral to the Siphonaptera in so far as the anatomical characters of the adults are concerned, and the Lepidoptera include forms exhibiting a tendency toward parasitism (e.g., *Cryptoses* parasitic on the sloth) and their larvæ are terrestrial instead of being aquatic as the typical trichopterous larvæ are—although some trichopterous larvæ live in moss, etc., suggestive of a common habitat for the primitive Lepidoptera (micropterygids) and Trichoptera. The maxillæ.

prothoracic sclerites and terminal abdominal structures of adult fleas, however, point more nearly to a trichopteroid ancestry for the Siphonaptera (see Crampton, 1923, 1926 and 1929), and the head structures of larval fleas are so much more like those of trichopterous larvæ, that I am more inclined to consider that both fleas and Lepidoptera were descended from trichopteroid forebears having many things in common with these two derived groups, and the resemblances between the Siphonaptera and Lepidoptera would therefore be due to their mutual relationship to the Trichoptera. In deriving fleas from such a trichopteroid ancestry, I would not minimize the evident resemblances between the fleas and the Diptera, Mecoptera, Neuroptera, Trichoptera and Lepidoptera, and if the lines of descent of these forms were portrayed graphically, they should be shown as a "bush-like" figure drawn as though branching in three planes, instead of being depicted as a dichotomously branching tree drawn in one plane. The complicated interrelationships of these insects can be more readily understood after each group has been compared with its nearest relatives in the general scheme of the holometabolous orders.

There is practically no dispute among recent investigators regarding the ancestry of the Diptera, which are apparently descended directly from the Mecoptera, or from Mecopteroid ancestors by way of the fossil Paratrichoptera (Protodiptera) such as *Aristopsyche*—which may be a true mecopteron, rather than a "paratrichopteron." The maxillæ (Crampton, 1932), the neck and prothoracic sclerites (Crampton, 1926), the terminal abdominal structures of the females (Crampton, 1929) and the male genitalia (Crampton, 1924, and 1931) are so similar in the two groups, that there can be no doubt whatsoever that the Mecoptera have preserved the ancestral features of the precursors of the Diptera in practically all of their structures in the adult condition—although the larval structures indicate that the Trichoptera as well as the Mecoptera are like the ancestors of the Diptera in many respects (Crampton, 1930). I have pointed out the resemblances between the mesothoracic terga of the Diptera and those of the Mecoptera (Crampton, 1919) and also called attention to the fact that such Neuroptera as the

Nemopteridæ foreshadow the modifications met with in the mesonota of the tipulid Diptera and the bittacid Mecoptera; and in the present paper I would call attention to the resemblances between the metathoracic and basal abdominal structures of the Diptera and Mecoptera, and the features in which these regions of the nemopterid neuropteron *Croce* foreshadow the conditions met with in the Diptera and bittacid Mecoptera.

The modifications occurring in the basal abdominal region of the bittacid mecopteron *Harpobittacus* shown in Fig. 16 are very like those exhibited by the ptychopterid dipteron *Bittacomorpha* shown in Fig. 13 in the slender character of this region of the abdomen, although the basal region of the more primitive dipteron *Protoplasa* shown in Fig. 9 is more like that of a primitive Mecopteron (Fig. 11) or even a primitive Neuropteron (Fig. 29). The metanotum *mn* in the Diptera shown in Figs. 9, 13 and 14 is greatly reduced, and the metathoracic pleural region is naturally much smaller than the mesothoracic pleural region due to the great reduction of the metathorax in all Diptera. An "adumbration" of the reduction of the metathorax of the Diptera is "foreshadowed" in the nemopterid neuropteron *Croce* shown in Fig. 10, in which the metathorax becomes markedly reduced, and the mesothoracic postscutellum *psl* is hugely enlarged (for a neuropteron) as the metanotum shrinks away from it, thus foreshadowing the condition exhibited in the Diptera more pronouncedly than is the case with these structures in the Mecoptera. Furthermore, the metathoracic coxa cx_3 of *Croce* (Fig. 10) has practically lost the meron present in lower Neuroptera (*me* of Fig. 29), although in certain Mecoptera such as *Boreus* (Fig. 6) the meron of the metathoracic leg is practically lost thus approaching the condition met with in the metathoracic leg of the Diptera (Figs. 9, 13, 14, etc.) in which the meron has completely disappeared. The venation of the hind wing of *Croce* (Fig. 10) suggests the beginning of the reduction of the hind wings to form the halteres of primitive Diptera which preserve traces of the venation in some Tipulids, etc., and the basal abdominal segments of *Croce* (Fig. 10) are very like those of certain tipulid diptera. The mouthparts of *Croce* and several other features suggest that the nemopterid

Neuroptera furnish the starting-point of the modifications met with in the Mecoptera and Diptera, but this does not mean that the nemopterid Neuroptera were the actual ancestors of either Mecoptera or Diptera. It does indicate, however, that in the original ancestral neuropteron stock there were developmental tendencies which would make themselves manifest in the derived mecopteron and dipteron groups, if given an opportunity for expression (by the proper combination of genes, etc.), and the condition exhibited by such Nemopterid Neuroptera as *Croce* may thus be regarded as adumbrations of the conditions later occurring in the Mecoptera and Diptera. This view is more probable than that both Diptera and Mecoptera were derived more or less independently from Neuropterous ancestors, since the Mecoptera (or mecopteroids) were evidently ancestral to the Diptera, although the Mecoptera themselves were apparently derived from primitive Neuroptera, which exhibited some features suggestive of the Diptera.

The Mecopteron *Nannochorista* shown in Fig. 7 has lost the sternite corresponding to the first abdominal tergite, so that in this respect, it is less primitive than the Dipteron *Protoplasa* shown in Fig. 9. The primitive trichopteron *Philopotamus* (Fig. 5) and the primitive Lepidoptera such as Mnemonica or Micropteryx (Fig. 4) which are extremely like *Philopotamus* in most of their structures (Crampton, 1920) both resemble *Nannochorista* (Fig. 7) very strikingly in the character of their basal abdominal and metathoracic structures (particularly in the character of the epimeron *em* and its connection with the post scutellum *psl*) and these representatives of the Lepidoptera, Trichoptera and Mecoptera shown in Figs. 5, 4, and 7, furnish an excellent series of forms leading from the Lepidoptera to the Trichopterous and higher mecopterous types, and from these to the lower mecopterous types (Fig. 11) leading to the primitive Neuroptera (Fig. 29). The color of these insects suggests that a very dark brown (or black) hue was characteristic of the series of insects leading from the Neuroptera to the Mecoptera (with the Diptera) and from these to the Trichoptera and Lepidoptera, instead of the yellowish brown which I formerly considered to be the color of the ancestors of these orders of insects. *Notio-*

thauma, which is the most primitive living representative of the Mecoptera is of a castaneous hue, and is more like the ancestral Mecoptera than is the pale brown *Merope,* which I formerly supposed was the most primitive representative of the Mecoptera, and this adds weight to the view that the ancestral Mecopteroids (from which the Diptera, Trichoptera, etc., were descended) were probably of a dark brown hue. The primitive Neuropteron *Sialis* is also dark brown in color, and it is more probable that the insects in the line of descent of the neuropteroids or mecopteroids (i.e., Neuroptera, Mecoptera, Diptera, Trichoptera, Lepidoptera, etc.) were originally dark brown in color.

In attempting to determine what the ancestors of the primitive neuropteroids were like, the condition exhibited by such primitive Mecoptera as *Chorista* (Fig. 11) and such Neuroptera as *Chauliodes* (Fig. 29) is of interest. The metathoracic meron *me* is well developed in these insects, and their ancestors must have had a well developed meron also. This feature would point to an isopteroid ancestral type resembling the termite shown in Fig. 28, in which the meron *me* is extremely well developed. Roaches, however, such as the one shown in Fig. 33, also have a fairly well developed meron *me,* and the roaches as well as the termites are like the protorthopteroid (or protoblattoid) ancestors of the Holometabola—and the dark brown color typical of many roaches and termites may have some significance in this connection. The roaches and termites, however, do not have a well developed postscutellum, typically present in Neuroptera, Mecoptera and other primitive Holometabola, and on this account such orthopteroid insects as the embiids and Plecoptera, in which the postscutellum is well developed (see description by Crampton, 1918), should be taken into consideration in attempting to reconstruct the types ancestral to the Holometabola, since the roaches and termites lack the postscutellum characteristic of the neuropteroid Holometabola.

The Psocid *Zorotypus* (placed in the Psocoptera for reasons given in the paper by Crampton, 1922) presents a condition intermediate between the neuropteroid Holometabola (and the Hymenoptera also) and the Isoptera, and serves to connect the

two groups of insects quite well. *Zorotypus* (Fig. 31) has a postscutellum *psl* like that of the neuropteroid Holometabola (Figs. 11, 29, 7, etc., *psl*), while the ventro-lateral region of the pleuron of *Zorotypus* (Fig. 31) is like that of a typical termite, such as the one shown in Fig. 28, in having a laterosternal sclerite *ls* well developed and clearly demarked—although such primitive Orthopteroids as *Grylloblatta* (Fig. 8) also have a well developed laterosternite *ls* and might be considered as somewhat annectant between the Isoptera and the lower Holometabola such as the Coleoptera, etc. Despite the fact that it has no metathoracic meron, however, the psocid *Zorotypus* (Fig. 31) is the best intermediate form I know of for connecting the lower Holometabola in general with the Isoptera-like forebears of the Holometabola, and the psocid group to which Zorotypus belongs also exhibits features in common with the embiids and other orthopteroids having a well developed postscutellum. In this connection, it may be mentioned that although it is frequently stated that the postscutellum is vestigial or wanting in the Orthoptera, I have found the largest postscutellum that I have ever encountered in any insect except the Strepsiptera (Fig. 25) in the orthopteron *Rhipipteryx* shown in Fig. 15, and many of the "bush-crickets," etc., have well developed postscutella, so that it is erroneous to suppose that the Orthoptera exhibit no tendency toward the development of a postscutellum.

In stating the *Zorotypus* is intermediate between the neuropteroid Holometabola and the Isoptera, and that the psocid group to which *Zorotyphus* belongs also exhibits affinities with the embiids, I would emphasize the fact that it is necessary to use a "three-dimensional" figure to express the complicated interrelationships of the different insectan orders in a satisfactory manner. Furthermore, in reconstructing the types ancestral to the Holometabola, we have to take into consideration not only the blattids and Isoptera, but also the embiids and Plecoptera, and certain other orthopteoids such as *Grylloblatta* and the Dermaptera as well, since some of these forms have retained ancestral features which others have lost, and in reconstructing the archetypal form from which the Holometabola were derived, we must combine the ancestral features from all of these primi-

tive orthopteroids, since no one of them has retained all of the ancestral features which we know must have occurred in the precursors of the Holometabola (judging by the character of the structures exhibited by the most primitive representatives of the Holometabola). When such an archetype had been constructed by combining ancestral features from these orthopteroids, I think that it would be extremely like the psocid *Zorotypus* in many respects (although it would probably have a well developed meron, which is lacking in *Zorotypus* and its venation would be much more primitive than that of *Zorotypus*) and on this account, I have maintained that *Zorotypus* is anatomically intermediate between the Holometabola and the orthopteroid types ancestral to the Holometabola, without implying that the Holometabola were descended from *Zorotypus* or any other psocid, for that matter. The ancestral features preserved by *Zorotypus,* however, indicate that it is closely related to the actual ancestors of the Holometabola, and its evident relationship to the Isoptera would indicate that the Isoptera are very like the forms giving rise to both psocids (*Zoraptera*) and Holometabola; but the Isoptera are not the ancestors of the Holometabola either, since the actual ancestors of the Holometabola were apparently forms in the common protorthopteron-protoblattid stem which exhibited features now retained in many orthopteroid insects such as the blattids, Isoptera, grylloblattids, Dermaptera, embiids and Plecoptera. So far as the posterior metathoracic and basal abdominal structures are concerned, I think that the Isoptera (Figs. 28 and 30) have retained most of the ancestral features exhibited by these "stem forms" in the pleural and basal abdominal regions, and in the basal region of the leg, with its well developed meron, but in the tergal region, the embiids and Plecoptera have retained the postscutellum which the Isoptera and blattids have lost, so that in this region the Zoraptera, represented by *Zorotypus,* which have retained a condition intermediate between the Holometabola and the ancestral orthopteroid group, are more like the embiids and Plecoptera than they are like the Isoptera and blattids, while in the pleural region and the basal abdominal region, the Zoraptera are more like the Isoptera. In the basal region of the leg, however,

the Zoraptera are too specialized to be intermediate between the lower Holometabola and the ancestral orthopteroids, since the Zoraptera have lost the meral sclerite which was doubtless present in the ancestral orthopteroids as well as in the lower Holometabola (or at least in the neuropteroid Holometabola).

The larval stages of the Strepsiptera are very like those of the meloid and rhipiphorid beetles, so that it is very disappointing to find that the posterior metathoracic and basal abdominal regions of a typical strepsipteron such as the one shown in Fig. 25, are not very like these regions in a typical rhipiphorid, such as the one shown in Fig. 27. The metathoracic coxa of the strepsipteron (Fig. 25) tends to unite with the pleural region, and the pleural sclerites are so peculiarly specialized in the Strepsiptera, that they furnish no serviceable clews for determining the types ancestral to the Strepsiptera. The metathoracic postscutellum (*psl* of Fig. 25) is hugely developed in the Strepsiptera, so that it is reasonable to suppose that the types ancestral to the Strepsiptera must have exhibited a marked tendency toward the enlargement of the metathoracic postscutellum, but the metathoracic postscutellum *psl* is quite small in the typical Rhipiphorid shown in Fig. 27, and the postscutellum is not greatly developed in any Coleoptera that I have been able to find, so that these structures do not furnish any serviceable clews for determining the ancestors of the Strepsiptera, and we must therefore depend upon the evidence of the larval characters for determining the closest affinities of the Strepsiptera. The evidence, such as it is, apparently points to a coleopteroid ancestry for the Strepsiptera, but I am more inclined to think that the Strepsiptera and Coleoptera were both descended from a common ancestry than to think that the Strepsiptera are the direct descendants of Rhipiphorids, or any other Coleoptera.

The Coleoptera are the most "orthopteroid" of all the Holometabola, and the Dermaptera are the orthopteroid forms which have retained the most features like those of the Coleoptera, although this does not imply that the Coleoptera were descended from the Dermaptera, but merely indicates that the Dermaptera have retained many characters present in the protorthopteroid ancestors of the Coleoptera and other Holometabola (i.e., the

forms in the common protorthopteron-protoblattid stem from from which the Holometabola were derived). I have already called attention to the strong resemblance between the maxillæ of the Coleoptera and those of the Dermaptera (Crampton, 1923), and to the striking resemblance between the tergal sclerites of the Coleoptera and those of the Dermaptera (Crampton, 1918), and when the basal abdominal structures and metathoracic pleural regions of the Coleoptera and Dermaptera shown in Figs. 32 and 34 are compared together, the resemblance is no less striking. The Dermapteron *Apachys* shown in Fig. 32 has an extremely large spiracle *sp* thus exhibiting a tendency for the first abdominal spiracle to become very large—a tendency which has been carried to the extreme in the lymexylonid coleopteron shown in Fig. 34, and the metathoracic epimeron and episternum *em* and *es* of *Apachys* (Fig. 32) are greatly elongated and assume a "horizontal" position as is the case in the lymexylonid (or lymexylid) beetle shown in Fig. 34. On the other hand, the character of the basal abdominal and metathoracic regions of the primitive Lycid beetle shown in Fig. 26 is very suggestive of the condition exhibited by the blattid shown in Fig. 33, in many respects, and both blattids and Dermaptera have evidently retained certain ancestral features suggestive of the precursors of the Coleoptera (and other Holometabola) from the actual ancestral forms in the common protoblattid-protorthopteron stem from which the Holometabola, including the Coleoptera, were derived. This view is in harmony with the fact that *Grylloblatta* and the Isoptera, as well as the blattids and Dermaptera, exhibit features suggestive of the ancestors of the Coleoptera, etc., and is much more probable than the view that the Coleoptera were descended from the Dermaptera alone.

The basal abdominal structures (with the spiracles borne in the sclerotized areas), the metathoracic postscutellum and metapleural sclerites of the lycid beetle shown in Fig. 26 are very suggestive of these structures in the primitive sawfly (Hymenopteron) shown in Fig. 24, and this resemblance lends weight to the view that the Hymenoptera and Coleoptera are quite closely related based upon resemblances in the venation of the two groups, as well as upon other features which the Coleoptera

(with the Strepsiptera) and Hymenoptera have in common—such as the absence of a meral region in the mesothoracic coxae, while all other Holometabola tend to preserve the meron in the mesothoracic leg. The basal abdominal and metathoracic sclerites of such sawflies as the ones shown in Figs. 23, 19, 21, etc., are likewise suggestive of those of the Dermapteron shown in Fig. 17, which is also in harmony with the fact that their relatives the Coleoptera likewise resemble the Dermaptera in these respects, but the regions in question in the Hymenoptera are very suggestive of those of the Isoptera (Figs. 28 and 30) as well, and in most respects the Isoptera are more like the ancestors of the Hymenoptera than the Dermaptera are. This is in harmony with the fact that the Zorapterous Psocids are related both to the Hymenoptera and to the Isoptera, being anatomically intermediate between the Hymenoptera and Isoptera in many respects. The Hymenoptera, however, were evidently descended from the forms in the common protorthopteron-protoblattid stem from which the rest of the Holometabola were derived, and whatever resemblances the Zoraptera and Isoptera exhibit with the Hymenoptera are due to the retention of ancestral features from the common orthopteroid stem from which they and the Hymenoptera also were derived.

While the absence of the mesothoracic meron in Hymenoptera and Coleoptera (with the Strepsiptera) and its presence in other Holometabola would indicate a closer relationship between the Hymenoptera and the Coleoptera (as is also indicated by the venation as well as the basal abdominal structures, the position of the spiracles and the metathoracic sclerites of primitive Coleoptera and Hymenoptera) the Hymenoptera are no less closely related to the Neuroptera and mecopteroid Holometabola as is shown by the *Chrysopa*-like head and the ocelli of many sawflies, and by the *Rhapidia*-like terminal abdominal structures of the sawflies Xyela, Sirex, etc., and by the Mecopteroid male genitalia, cerci, larval characters, etc., of primitive Hymenoptera. We may therefore consider that the Hymenoptera occupy a position intermediate between the Coleoptera on the one side, and the Neuroptera with the mecopteroid insects, on the other,

and their ancestors had much in common with the Zorapterous psocids and the Isoptera.

In attempting to find the hymenopterous type intermediate between the sawflies (Chalastogastra) and the stinging Hymenoptera (Clistogastra) a study of the basal abdominal region (which is one of the important features for separating the sawflies from the stinging Hymenoptera) would indicate that the usual view that the oryssids, such as the one shown in Fig. 19, exhibit tendencies leading to the stinging type of Hymenoptera is incorrect, since the Cephidæ, such as the one shown in Fig. 18, exhibit a striking tendency toward the formation of a deep constriction between the first and second abdominal segments, and this tendency, if carried still further, would result in the formation of a pronounced constriction between the first and second abdominal segments (accompanied by a narrowing and elongation of the second abdominal segment) exhibited by the sting-bearing Hymenopteron shown in Fig. 20. Even in the sting-bearing Hymenopteron shown in Fig. 20, the first abdominal tergite labelled 1^t is broadly joined to the thorax, so that the abdomen is as broadly joined to the thorax (metathorax) in the sting-bearing Hymenoptera as it is in the sawflies, and it is most inaccurate to speak of one group as having the abdomen broadly joined to the thorax and the other as having a constriction between the abdomen and thorax, since no Hymenoptera seem to have a deep constriction between the thorax and abdomen, the actual constriction being between the first and second abdominal segments—as the systematists have long known to be the case, although they have persisted in retaining the incorrect descriptive designations handed down from the time when it was supposed that the first abdominal tergite (propodeum) was in reality the metanotum, and the true second abdominal segment of stinging Hymenoptera was interpreted as the first abdominal segment, as has been pointed out by Packard, Brauer, and many other investigators.

The condition exhibited by the cephid sawfly shown in Fig. 18 suggests that the narrow anepisternal and anepimeral regions *aes* and *aem* (i.e., the upper regions of the episternum and epimeron) form the narrow upper metapleural region labelled

aes in the ichneumonid hymenopteron shown in Fig. 20, although the anepisternum forms a larger part of this upper metapleural region than the anepimeron does. The katepimeron *kem* or lower portion of the epimeron in Fig. 18 becomes very narrow in Fig. 20, while the katepisterum *kes* or lower portion of the episternum in Fig. 18 forms the greater portion of the metapleuron labelled *kes* in Fig. 20. The propodeum 1^t of Fig. 20 is formed by the first abdominal tergite, labelled 1^t in Fig. 18. The second abdominal tergite 2^t of Fig. 18 tends to become markedly constricted basally (anteriorly) and in Fig. 20 it has apparently extended downward (in the anterior region) crowding the second sternite 2^s backward in the process, and in such stinging Hymenoptera I think that most of the petiole is formed by the second abdominal tergite rather than by the union of the second sternite and tergite. The region labelled *tm* in Fig. 18 apparently corresponds to the region called the tergomarginale (or tergomarginal sclerite) in the roach, etc., and, in Fig. 20, this sclerite (tm) forms a structure of use in the movements of the abdomen.

Many recent investigators regard the siricids as the nearest living representatives of the ancestors of the lower Hymenoptera. The character of the metathoracic and basal abdominal structures of the siricids very clearly indicates that the siricids such as the one shown in Fig. 21 are like the ancestors of such sawflies as the xiphidriidid shown in Fig. 23 and the oryssid shown in Fig. 19 (which is too much like these other siricoids to be placed in a different suborder from them) but the siricids (Fig. 21) are not like the ancestors of such sawflies as the one shown in Fig. 22, since these sawflies apparently lead back to ancestors more closely resembling the "Lydid" sawfly *Cephaleia* shown in Fig. 24 and the Xyelidæ, and I think that the latter sawflies are much more primitive than the siricids. *Cephaleia* has many features suggestive of orthopteroid affinities, and its ancestors were apparently derived from Isoptera-like forebears in the common protoblattid-protorthopteron stem instead of being the descendants of the fossil insects called "Protohymenoptera" by Tillyard, since Carpenter, 1931, has recently shown that the so-called "Protohymenoptera" are in reality specialized

Megasecoptera having nothing to do with the ancestors of the Hymenoptera. In this connection it may be remarked that the interpretation of the venation of the fore wing of the Hymenoptera suggested by a comparison with the fore wing of a Psocid, as given in Figs. 66 and 65 of Plate 9 in Vol. LIV of the Canadian Entomologist for 1922, is more nearly correct than the new interpretation suggested by Tillyard whose conclusions are based upon a comparison of the Hymenoptera with the unrelated Megasecoptera, in which he has mistaken the lower surface of the wing for the upper one, and consequently has confused the concave and convex veins, as was pointed out by Carpenter, 1931, who obtained some excellently preserved specimens of the "*Protohymenopterous*" Megasecoptera from the Kansas Permian formations, and was able to determine the character of the body of these insects as well as their wings.

When the bodies of the so-called "Protohymenoptera" were studied, it was found that their body structures were typically those of Megasecoptera, and the superficial resemblance of their wings to those of the Hymenoptera was found to be merely the result of convergence. This instance very clearly illustrates the inadvisability of basing one's conclusions on one set of structures alone. It is so easy to say that the disembodied wings of some fossil insect are ancestral to some modern group of insects, that there is a great temptation to claim to have found the actual ancestors of a modern group whenever one discovers some fossil wings that resemble those of any modern group, without waiting to discover what the body of the insect which originally bore the fossil wings was like, in order to determine if the ancestral relationship claimed for the fossil wings could be substantiated. The phenomenon of "heterospecialization" or unequal specialization in the different parts of the body of any one insect should make us very hesitant about accepting such claims based upon the study of the wings alone, since, as in the case of the so-called "Protohymenoptera," a study of the body might wholly overthrow the theory of an ancestral relationship based upon the study of the wings alone, and until something is known about the body of the insect which bore them, we cannot justly claim an ancestral relationship for any insect whose wings alone are

known. If it is found, however, that the relationships indicated by the wings are borne out by the study of other parts of the body, using for this purpose archetypes made by selecting the primitive features exhibited by the lowest representatives of each group of insects (or by the annectant types serving to connect several groups of insects) one can be much more confident that his conclusions are correct. Most of the recent students of insect phylogeny, however, are unwilling to make such studies themselves, and are not even willing to consider the evidence presented by others who have made such studies, with the result that it is impossible to find a reference in the text or bibliographies of most palæoentomological papers to any studies of structures other than the wings, and the same is true of all recent text-books and so-called reviews of recent advances in entomology, with the result that beginning students and investigators alike are as completely ignorant of any evidence of relationships of insects, other than that furnished by the wings, as though such evidence did not exist. This attitude of utterly ignoring the easily accessible evidence already available for checking one's conclusions based upon one set of structures alone, is hardly in keeping with the modern scientific spirit; and when the students of wing-veins alone are at length willing to give enough consideration to the evidence of other structures as well (for understanding the interrelationships of insects) to be able to appreciate their value for checking the evidence from other sources, the study of various structures from widely different parts of the body will receive the consideration that it deserves instead of being completely ignored as is the case at present!

Since the evidence of the mouthparts, neck and prothoracic sclerites and terminal abdominal structures of female insects clearly supports the evidence of the wing-veins indicating that the blattids (with the protoblattids) Mantids and Isoptera form a compact superorder of insects (the Panisoptera) representing more closely than any others the protoblattoid ancestors of the Neopterygota, or higher insects capable of laying the wings back along the abdomen in repose (i.e. the orthopteroids, hemipteroids, psocoids and Holometabola), we may safely conclude that all of these Neopterygota were ultimately descended from

protoblattoid ancestors in the common protoblattid-protorthopteran ancestral stem.

The evidence of the head capsule, thoracic sclerites and terminal abdominal structures points to the psocoids (including the Zoraptera) and to some extent to the Homoptera, as the intermediate types connecting the Holometabola with the ancestral protoblattoids in the common protoblattid-protorthopteran stem; but the wing-veins of the Zoraptera, for example, are too specialized to serve as connecting links, as many of the body structures do in the Zoraptera, so that in this case the venational archetypes must be reconstructed from other sources, and, of living insects, the blattoid insects have retained more venational features suggestive of the ancestors of the Holometabola than any other recent forms have. In fact, I consider that the common ancestor of the holometabolous insects was more nearly a protoblattid than anything else (judging from the venational evidence), although it evidently exhibited many protorthopteran features as well.

The Holometabola as a group exhibit too many characters in common (especially in their larval stages) to be of a polyphyletic origin. The Coleoptera (with the lampyroids and silphids as their most primitive representatives) are the most orthopteroid of the Holometabola in their general body structures, but the Neuroptera have retained a more primitive venation than the Coleoptera, and have also remained more primitive in their general body structures than have the Mecoptera, which have also retained a very primitive venation. The Coleoptera are more like the Neuroptera in their larval stages, but in the general character of the structures of the body, they are more closely allied to the Hymenoptera, which exhibit characters annectant between the Coleoptera, on the one side, and the Neuroptera and Mecoptera on the other. We are thus obliged to consider the venational evidence furnished by the Neuroptera and their allies the Mecoptera in determining their probable ancestral types, but the general body characters of the adults (and larvæ) are of more value for determining the affinities of the Coleoptera—although so far as their relationship to the Hymenoptera is concerned, the venational evidence is of some value also.

The various body structures are in complete agreement with the venational evidence in pointing to a close relationship between the Neuroptera, Mecoptera, Diptera, Trichoptera and Lepidoptera, but the body structures in general would indicate that the Neuroptera are more primitive than the Mecoptera are, and would point to an extremely close relationship between the Mecoptera and the Diptera, and between the Trichoptera and the Lepidoptera, although the Trichoptera are evidently related to the Diptera, Mecoptera and Neuroptera as well.

Of the specialized parasitic orders, the Strepsiptera are evidently closely related to the rhipiphorid Coleoptera, as is indicated by their larval structures; but their relationship to the rhipiphorids is not indicated by many structures of the adults, unless we attach especial weight to such rather trivial structures as the antennæ, etc. The fleas, on the other hand, occupy a rather isolated position, and it is extremely difficult to determine their closest affinities. They undoubtedly exhibit certain larval features suggestive of affinities with the Diptera, but on the whole they present more features in common with the Trichoptera (and their relatives the Lepidoptera). The fleas are likewise related to the Mecoptera and the Neuroptera; but their relationship to the Coleoptera is much more distant, and they have but slight affinities with the Hymenoptera.

In order to express all these interrelationships, we may divide the Holometabola into three superorders. The first superorder, or *Pansiphonaptera*, includes the Siphonaptera (fleas) alone, and represents a rather isolated group (related to the Trichoptera, Lepidoptera, Diptera, Mecoptera and Neuroptera) characterized as follows. They are laterally compressed apterous forms, with piercing mouthparts in which the labial palpi are composed of at least three segments, and the submental sclerite is usually distinct and well sclerotized. The mesothorax and metathorax are subequal. The pleural suture tends to remain more vertical, and the meron is frequently demarked in the meso- and metathorax. The abdominal spiracles are borne in sclerotized areas and what appear to be cerci are present in the terminal abdominal region of many fleas. They might be included

in the next superorder, but are hardly to be included with the Coleoptera.

The superorder *Panmecoptera* includes the Neuroptera, Mecoptera, Diptera, Lepidoptera and Trichoptera, with their fossil allies (such as Belmontia, Aristopsyche, etc.) and may be characterized as follows. Typically winged forms in which there is a tendency to suppress the anal region of the hind wings although certain Trichoptera do not exhibit this tendency very strongly. The body tends to be more robust than compressed. The mesothoracic leg typically exhibits a demarked meron. The metathorax is smaller than the mesothorax in some forms. The abdominal spiracles are typically borne in the lateral membranous region. The male genitalia are typically forcipate. The cerci are frequently developed. Within the superorder, the Mecoptera are very closely allied to the Diptera, and the Trichoptera are very closely allied to the Lepidoptera. The Neuroptera are allied to both Mecoptera and Trichoptera, though the line of development of the Trichoptera apparently joins that of the Mecoptera as they both lead back to neuropteroid forebears to which the Mecoptera are the more closely related.

The superorder *Pancoleoptera* includes the Coleoptera, Strepsiptera and Hymenoptera, with their fossil allies (but does *not* include the so-called "Protohymenoptera"). The body is more robust, and tends to become more depressed in some members of the group (certain Coleoptera). The hind wings sometimes retain a faint suggestion of traces of the anal fan of their orthopteroid ancestors. The mesothoracic legs never exhibit a demarked meron (thus differing from the members of the preceding superorder). The metathorax sometimes surpasses the mesothorax in size, and the metathoracic pleural suture frequently becomes more horizontal than vertical. The abdominal spiracles are usually surrounded by sclerotized areas, thus differing from the preceding superorder. Cerc iand forcipate genitalia are developed only in the Hymenoptera, which are thus more like the Mecoptera than the Coleoptera are, and the larvæ of the Hymenoptera are more like those of the Mecoptera, Lepidoptera, etc., than the larvæ of the Coleoptera are, although the larvæ of certain Coleoptera are striking like those of certain

Neuroptera, and the wings of adult Coleoptera are more like those of the Neuroptera than is the case with the Hymenoptera. Although the Hymenoptera resemble the Mecoptera in many respects, and the Coleoptera resemble the Neuroptera in many respects, the Hymenoptera and Coleoptera (with their offshoots, the Strepsiptera) have been grouped in the same superorder because of their many similarities. When more is known of the fossil relatives of these insects, they might be placed in distinct superorders, but in the present state of our knowledge it is inadvisable to separate them further.

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ABBREVIATIONS

The subscripts 2 to 3 written after the labellings indicate that the structure designated by the label belongs to the mesothorax and metathorax respectively. The letters t and s written to the right and above the numerals denote the tergite and sternite of the abdominal segment indicated by the numerals.

aem	Anepimeron (upper region of epimeron)
aes	Anepisternum (upper region of episternum)
bs	Basisternum
cx	Coxa
ec	Eucoxa (anterior division of coxa)
em	Epimeron
es	Episternum
fe	Femur
fs	Furcasternum
h	Basal portion of halter
kem	Katepimeron (lower region of epimeron)
kes	Katepisternum
le	Lateral extension of furcasternum
ls	Laterosternite
m	Mediotergite (median region of postscutellum)
me	Meron
mn	Metanotum
ms	Mesonotum
p	Pleurotergite (lateral region of postscutellum) also called postalare
pes	Preepisternum

po	Posthaltere
pr	Prehaltere
ps	Pleural suture
psl	Postscutellum
sl	Scutellum
sp	Spiracle
st	Subtergite
tn	Trochantin
tm	Tergomarginale (marginal sclerite of tergite)
tr	Trochanter

PLATES

Unless otherwise stated, all figures represent lateral views of the posterior metathoracic and basal abdominal region of the insect's left side. The anterior region is directed toward the left hand margin and the dorsal region is directed toward the top of the plate. Wings and halteres are cut off, and the legs are cut off below the coxa in most cases.

PLATE XX

Figure 1. Mesothorax, metathorax and basal abdominal region of the dog flea with mesothoracic coxa remoxed to show the lateral extension of the furcasternum *lc* extending along its mesal face.

Figure 2. Posterior metathoracic and basal abdominal region of the Lepidopteron Danaus archippus.

Figure 3. Same of the coleopteron *Platypsylla*.

Figure 4. Same of the lepidopteron *Eriocrania calthella*.

Figure 5. Same of the trichopteron *Philopotanus*.

Figure 6. Same of the mecopteron *Boreus*.

Figure 7. Same of the mecopteron *Nannochorista dipteroides*.

Figure 8. Same of the orthopteron *Grylloblatta campodeiformis*.

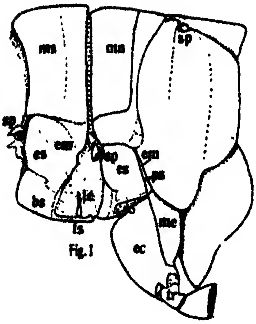

Fig. 1

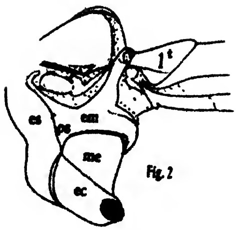

Fig. 2

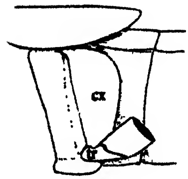

Fig. 3

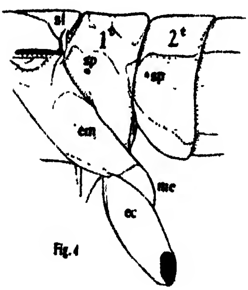

Fig. 4

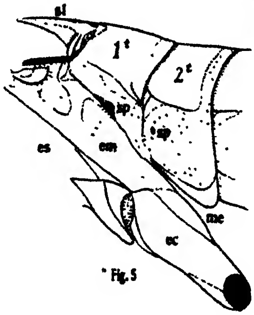

Fig. 5

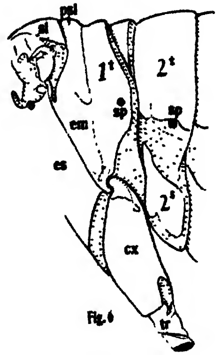

Fig. 6

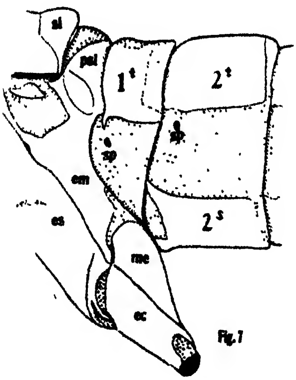

Fig. 7

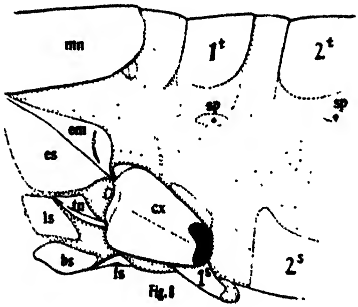

Fig. 8

PLATE XXI

Figure 9. Posterior mesothoracic, lateral metathoracic and basal abdominal region of the tanyderid dipteron *Protoplasa fitchii.*

Figure 10. Same of the nemopterid neuropteron *Croce filipennis.*

Figure 11. Posterior metathoracic and basal abdominal region of the mecopteron *Chorista australis.*

Figure 12. Posterior mesothoracic, lateral metathoracic and basal abdominal region of the dipteron *Leptis.*

Figure 13. Same of the dipteron *Bittacomorpha clavipes.*

Figure 14. Same of a mycetophilid dipteron *Sciara* sp. from Mexico.

Figure 15. Posterior metathoracic and basal abdominal region of the orthopteron *Rhipteryx atrata.*

Figure 16. Same of the mecopteron *Harpobittacus.*

Figure 17. Same of the dermapteron *Arixenia.*

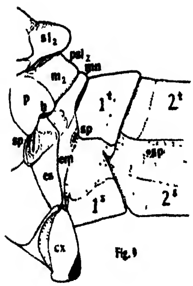

Fig. 9

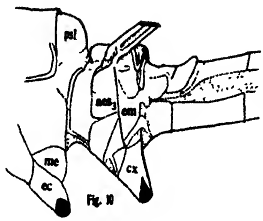

Fig. 10

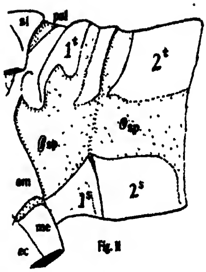

Fig. 11

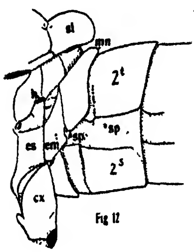

Fig. 12

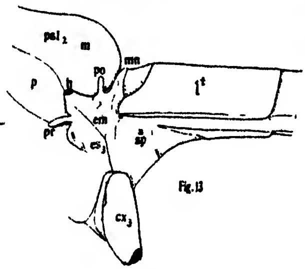

Fig. 13

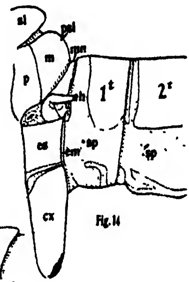

Fig. 14

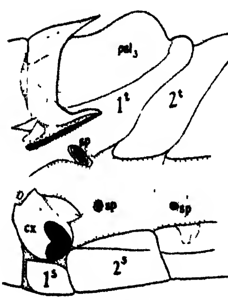

Fig. 15

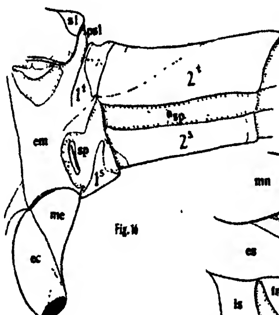

Fig. 16

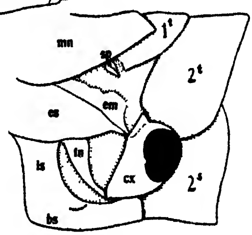

Fig. 17

PLATE XXII

Figure 18. Same of the cephid hymenopteron *Cephus* (Janus ?).
Figure 19. Same of hymenopteron *Oryssus*.
Figure 20. Same of ichneumonid hymenopteron *Megarhyssa*.
Figure 21. Same of hymenopteron *Sirex*.
Figure 22. Same of tenthredinid hymenopteron *Abia*.

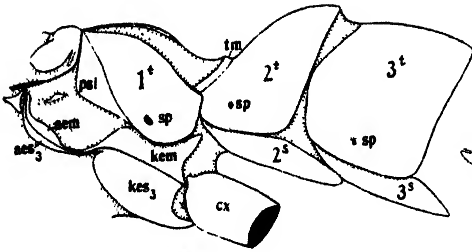

Fig. 18

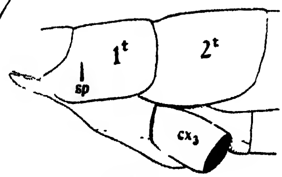

Fig. 19

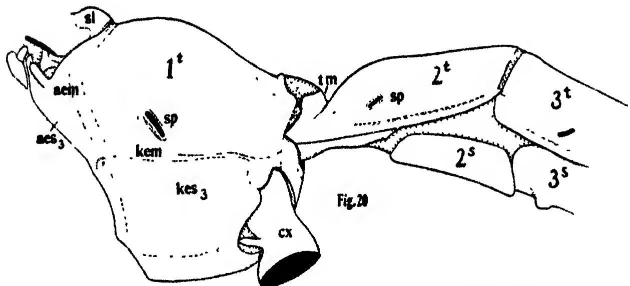

Fig. 20

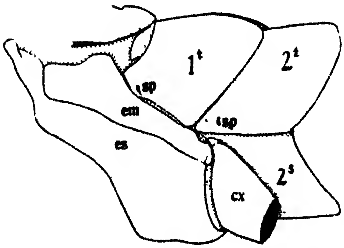

Fig. 21

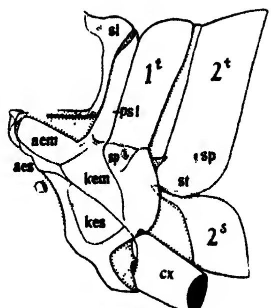

Fig. 22

PLATE XXIII

Figure 23. Same of hymenopteron *Xiphidria.*
Figure 24. Same of lydid sawfly.
Figure 25. Same of strepsipteron (probably *Xenos*).
Figure 26. Same of lycid coleopteron.
Figure 27. Same of rhipiphorid coleopteron.

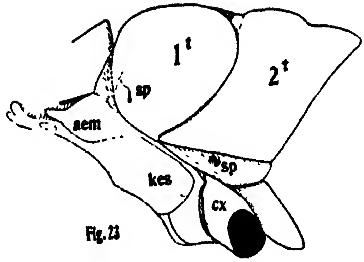

Fig. 23

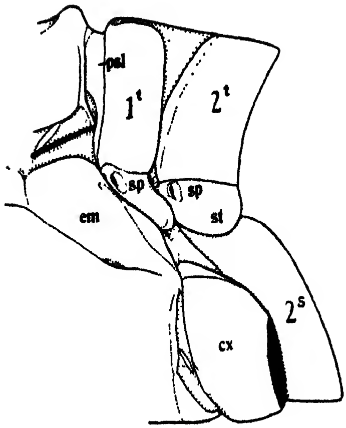

Fig. 24

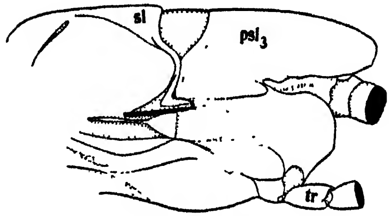

Fig. 25

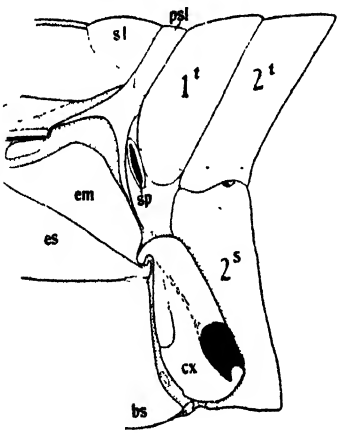

Fig. 26

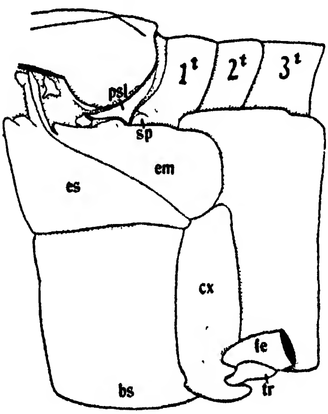

Fig. 27

PLATE XXIV

Figure 28. Same of isopteron *Leucotermas flavipes* (alate caste).
Figure 29. Same of sialid neuropteron *Chauliodes.*
Figure 30. Same of termite *Termes bellicosus* (soldier caste).
Figure 31. Same of zorapterous psocid *Zorotypus snyderi.*
Figure 32. Same of dermapteron *Apachys.*
Figure 33. Same of roach *Periplaneta americana.*
Figure 34. Same of lymexylid (lymexylonid) coleopteron.

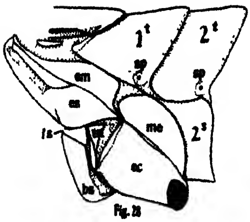

Fig. 28

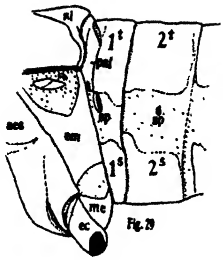

Fig. 29

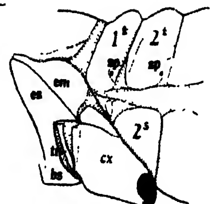

Fig. 30

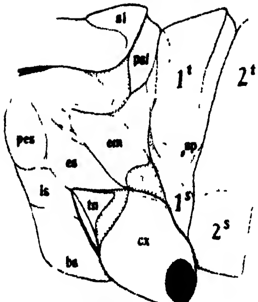

Fig. 31

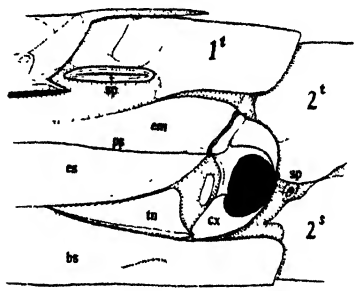

Fig. 32

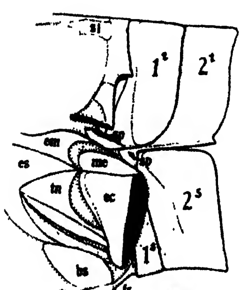

Fig. 33

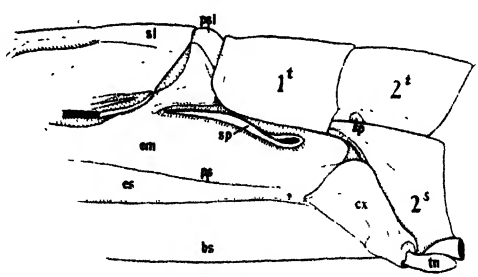

Fig. 34

STUDIES IN AMERICAN SPIDERS: GENERA, CORNICULARIA, PARACORNICULARIA, TIGELLINUS, WALCKENAERA, EPICERATICELUS AND PELECOPSIS, WITH DESCRIPTIONS OF NEW GENERA AND SPECIES

BY C. R. CROSBY AND SHERMAN C. BISHOP

CORNICULARIA Menge

Preussische Spinnen p. 226. 1868.

Type. *Cornicularia unicornis* Cambridge.

In this genus the abdomen is without hardened sclerites and the males do not have holes in the head. The tibia of the male palpus has a long apophysis either single or double with a deep rounded emargination on the lateral side. The embolic division of the bulb is of the spiral type as in Grammonota, Ceraticelus, Ceratinella and Ceratinopsis, approaching more closely the latter. There is no break in the embolus near the tip as in Ceraticellus and Ceratinella. The males exhibit as a secondary sexual character a single or double horn-like process arising from the median ocular area. It does not seem useful to retain longer the genus Prosopotheca based on the size and arrangement of the eyes since a division of the group on these characters separates in some cases species otherwise very closely related.

Species described as Cornicularia placed elsewhere

Cornicularia monticolens Chamberlin. Ent. Soc. Am. Annals 12: 251, 1919. Now placed in Spirembolus. See Cal. Acad. Sci. Proc. (Ser. 4) 14: 113, 1925.

Cornicularia formosa Banks. Phila. Acad. Nat. Sci. Proc. 1892, p. 34. Now placed in Ceratinopsidis. See N. Y. Ent. Soc. Jour. 38: 29. 1930.

Cornicularia recurvata Banks. Wash. Acad. Sci. Proc. 2: 479. 1900. Placed in Walckenæra by Petrunkevitch. The form of the horn and of the tibial apophysis would exclude it from Cornicularia.

Cornicularia varipes Banks. Wash. Acad. Sci. Proc. 2: 479. 1900. Placed in Walckenæra by Petrunkevitch. Without the male this species cannot be placed with certainty.

A species described as Prosopotheca and its subsequent history

Prosopotheca transversa Crosby. Phila. Acad. Nat. Sci. Proc. 1905 p. 333.

This was based on an immature female of *Bathyphantes formica* Emerton. This species was redescribed again from a female by Petrunkevitch (N. Y. Ent. Soc. Jour. 33: 173. 1925) as *minutum* for which he erected the new genus *Tennesseellum.* Later (Conn. Acad. Sci. Trans. 29: 125, 1928) he erected for this genus the new sub-family Tennesseellinæ in the Linyphiidæ. That this species needs a sub-family or even a separate genus for its reception is extremely doubtful. The fact that the spiracular sulcus is some distance in front of the spinnerets is evidently the result of a modification towards becoming an ant-mimic. In other respects it is closely related to other species of the group. The position of the spiracular sulcus is of specific value only in Hahnia and of generic significance only in the Anyphæninæ (Anyphæna and Gayenna).

KEY TO THE AMERICAN SPECIES OF CORNICULARIA, MALES

1.	Cephalic horn single	2
	Cephalic horn double	5
2.	Tibial apophysis single	3
	Tibial apophysis double	4
3.	Horn erect (Figs. 37–38)	*minuta* Em.
	Horn low, not higher than the posterior eyes (Figs. 8–9).	*brevicula* n. sp.
4.	Horn clavate (Figs. 21–22).	*clavicornis* Em.
	Horn not clavate (Figs. 1–2)	*auranticeps* Em.
5.	Horn short.	6
	Horn long	8
6.	Horn nearly erect	7
	Horn directed forward, upper lobe overhanging the lower (Figs. 15–16).	*brevicornis* Em.
7.	Length 1.4. Tibial apophysis minutely dentate laterally. Head not noticably darker than thorax (Figs. 52–56)	*tumida* n. sp.
	Length 2.6. Tibial apophysis not minutely dentate laterally. Head noticeably darker than thorax (Figs. 43–48)	*pallida* Em.
8.	Cephalothorax chestnut brown	9
	Thorax orange	11

9. **Horn noticeably narrowed at base, upper lobe rounded (Figs. 49 and 51) . . . . *tibialis* Em.**
Horn not of this form 10
10. **Horn long and slender (Figs. 27–28) . . . . *directa* Cambr.**
Horn shorter and thicker (Figs. 6–7) . . . . *breviaria* n. sp.
11. **Thorax orange, head slightly dusky.**
Abdomen dark gray (Figs. 24–26) . . . *communis* Em.
Thorax reddish orange, head nearly black. Abdomen yellow (Figs. 34–36) . . . . . *indirecta* Cambr.

Cornicularia auranticeps Emerton
(Figures 1–5)

Cornicularia auranticeps Emerton. Conn. Acad. Sci. Trans. 6: 43, pl. 8, fig. 6. 1882.
Cornicularia auranticeps Simon. Hist. Nat. Ar. 1: 626. 1894.

Male. Length, 2.2 mm. Cephalothorax bright orange yellow, viewed from above evenly rounded on the sides, slightly constricted at the cervical groove, broadly rounded across the front; viewed from the side steeply ascending behind and then gently rounded over to the base of the horn. Median ocular area occupied by a rather thick short, single, flat-topped horn, directed slightly forward. Clypeus almost vertical and very slightly concave. Viewed from above the horn is seen to be fringed on each side by a row of short recurved hairs.

Posterior eyes in a procurved line, equal, the median separated by the radius and from the lateral by the diameter. Anterior eyes in a very slightly recurved line, the median a little smaller than the lateral, subcontiguous and separated from the lateral by the radius.

Sternum, labium and endites bright orange yellow. Coxæ, trochanters and femora orange yellow like the cephalothorax; the tip of first and second femora and succeeding segment distinctly dusky. Abdomen black. Femur of palpus rather long, slender, and slightly curved inward. Patella short, straight and slightly widened distally. Ratio of length of femur to that of patella as 11 to 4. Tibia short provided dorsally with two long, incurved divaricate apophyses. The lateral apophysis strongly curved inward distally and finely denticulate across the truncated margin. Tailpiece of the embolic division rather long, distinctly bent, the tip reaching to the edge of the tegulum.

The embolus rather slender making one complete flat turn around the end of the bulb.

Female. Length, 2.5 mm. Similar to male in form and color. Posterior eyes in a very slightly recurved line, equal and equidistant separated by a little less than the diameter. Anterior eyes in a recurved line, the median slightly smaller than the lateral, subcontiguous, separated from the lateral by a little less than the radius. The epigynum has the middle lobe slightly oval in outline overlaid in front by a broad, rounded lobe projecting backward.

We are indebted to Mr. Nathan Banks of the Museum of Comparative Zoology for the loan of the specimen from Holliston, Mass.

Massachusetts: Holliston, Nov. 29, 1923. 1 ♂ (Emerton).

New York: Albany, June 2, 1921. 1 ♀; Little Pond, Orange Co., May 25, 1920. 1 ♀.

Cornicularia breviaria new species
(Figures 6–7)

Male. Length, 2.2 mm. Cephalothorax chestnut brown; viewed from above rather long and narrow, evenly rounded on the sides, slightly constricted at the cervical groove and narrowed towards the front, the front not in view because of the horn. Cephalothorax viewed from the side rather steeply ascending behind and then almost straight to the tip of the horn. Clypeus almost straight and somewhat retreating.

Posterior eyes in a slightly procurved line, equal, the median separated by one-third of the diameter and from the lateral by two-thirds of the diameter. Anterior eyes in a slightly recurved line, equal, the median subcontiguous and a little farther from the lateral.

Sternum dusky orange darker at the margin. Labium and endites lighter. Legs orange. Abdomen dark gray almost black. Tibia and tarsus like that of *brevicornis.*

Holotype male. Interlaken, New York. Nov. 26, 1915.

Cornicularia brevicula new species
(Figures 8–11)

Male. Length, 2.1 mm. Cephalothorax dark brown, almost black; viewed from above noticeably broad, evenly rounded on the sides, slightly constricted at the cervical groove and broadly and bluntly rounded across the front; viewed from the side, gently ascending behind in a straight line to the cervical groove where there is a broad shallow depression, then evenly rounded over the head to the posterior eyes. Just in

front of the posterior median eyes there is a very small short horn clothed with a few recurved hairs. Clypeus almost vertical and slightly concave.

Posterior eyes in a very slightly recurved line, the median slightly smaller than the lateral, separated by the radius and a litlle farther from the lateral. Anterior eyes in a slightly recurved line, equidistant, separated by less than the radius. Sternum dark brown, black at margin. Labium black, lighter at tip. Endites dusky orange. Legs and palpi yellow tinged with orange. Abdomen light greenish gray.

Femur of palpus cylindrical and slightly curved inward. Patella rather stout. Ratio of length of femur to that of patella as 24 to 12. Tibia short and broad with a long stout incurved dorsal process which is deeply excavated laterally to form a deep concavity, on the mesal side it is gradually widened at the middle forming a low lobe. The tip of this apophysis is very thin, rounded and lies close to the cymbium. The whole apophysis and the opposing lateral lobe of the tibia is deeply hollowed out to form a groove. The paracymbium is rather stout, strongly curved but without a distinct notch before the tip. The tail-piece of the embolic division is flat and bluntly pointed with the tip lying in a notch of the tegulum. The terminal part of the embolic division consists of a stylus which is broad at the base and rapidly narrows distally. It is spirally coiled in one turn about the end of the bulb. The tip is straight and projects tangentially to the soil.

Holotype male, New York: Mt. Marcy, Aug. 27, 1930. Two ♂ specimens were taken, one not fully colored.

Cornicularia brevicornis Emerton

(Figures 12–17)

Cornicularia brevicornis Emerton. Conn. Acad. Sci. Trans. 6: 42, pl. 11, fig. 5, 1882.

Prosopotheca brevicornis Simon. Hist. Nat. Ar. 1: 626. 1894.

Male. Length, 2.6 mm. Cephalothorax reddish orange, the whole head darker; viewed from above elongate, the sides evenly rounded on the thoracic part, a broad shallow constriction at the cervical groove in front of which the sides are again rounded; viewed from the side rather steeply ascending behind, nearly level along the back and then gradually ascending and rounded over the head to the posterior eyes. The horn is short and blunt and not elevated above the level of the posterior median eyes; clothed in front and on the sides with short, stiff recurved hairs, a median longitudinal strip bare. The lower member short and

closely applied to the upper part, in side view right-angled. Clypeus nearly straight, somewhat retreating.

Sternum orange, smooth, sparsely clothed with stiff black hairs; endites a little lighter. Legs orange yellow. Abdomen dark gray.

Posterior eyes in a slightly procurved line, the median slightly smaller than the lateral, separated from each other by twice the diameter and from the lateral by the diameter. Anterior eyes in a slightly recurved line, the median smaller than the lateral, separated by the radius and a little further from the lateral.

Femur of palpus straight and nearly the same thickness throughout its length; patella short, arched above and only a little wider distally; tibia without the apophysis short and greatly widened, dorsally armed with a very long, stout, black, process which curves laterally over the face of the cymbium; mesally, at the base of the process there is a squarish lobe, laterally from the process there is a large, deep semicircular notch, the margin of which is hollowed out to form a deep groove, this groove extending to the tip of the apophysis. Paracymbium rather stout, strongly curved with a blunt, black, tooth which is hooked at the tip. Tail-piece of the embolic division thin and pointed, forming nearly a right angle with the middle part, the terminal part broad and stout at base but soon narrowing into a smooth curved black rod which makes one small, complete turn around the tip of the bulb.

Female. Length, 2.5 mm. Similar to the male in color. Posterior eyes in a straight line, the median slightly smaller than the lateral, separated by the radius and from the lateral by a little less. Anterior eyes in a slightly recurved line, all subcontiguous, the median smaller than the lateral. The epigynum rectangular in outline. The middle lobe broad behind and narrowed toward the front, with its posterior margin gently biconvex.

Type locality: New Haven, Conn.

Allotype locality: Columbia, Mo.

New York: Riverhead, April 11, 1923, 2 ♂; Mt. Whiteface, Aug. 22, 1916, 1 ♂.

Massachusetts: Cambridge, April, 1906, 1 ♂, 1 ♀.
Illinois: Salts, May 24, 1926, 1 ♂ (Smith).
Missouri: Columbia, Nov. 1905, 1 ♂ 2 ♀; without date 1 ♂; 1905; Dec., 1904, 2 ♀; Nov. 22, 1904 (on fence), 2 ♀.
Georgia: Tallulah Falls, Oct. 18, 1926, 1 ♂.

Cornicularia clavicornis Emerton
(Figures 18–23)

Cornicularia clavicornis Emerton. Conn. Ac. Sci. Trans. 6: 43, pl. 8, fig. 6. 1882.
Cornicularia clavicornis Simon. Hist. Nat. Ar. 1: 626. 1894.
Cornicularia clavicornis Crosby. Phila. Acad. Nat. Sci. Proc., p. 308. 1905.

Male. Length, 2 mm. Cephalothorax dusky orange, head not noticeably darker; viewed from above rounded on the sides, convergent towards the front, broadly rounded across the front, the horn not projecting in front of the clypeus; viewed from the side gently arched to the posterior eyes. The horn nearly quadrate in side view, slightly wider at top than at base and directed obliquely forward. Clypeus very slightly concave and almost vertical.

Posterior eyes in a procurved line, equal, the median separated by a little less than the diameter and from the lateral by slightly more. Anterior eyes in a very slightly recurved line, the median a little smaller than the lateral, subcontiguous and separated from the lateral by a little less than the radius.

Sternum and labium dusky orange darker at margin; endites yellow, lighter at tip. Legs orange yellow. Abdomen dark gray.

Femur of palpus moderately stout, slightly curved downward, gradually widened distally; patella nearly straight. Ratio of length of femur to that of patella as 16 to 7. Tibia very short and provided with two very long apophyses, the lateral apophysis is slender, gently curved and stands out free from the cymbium. The mesal apophysis lies close to the cymbium and curves under the lateral apophysis. At some distance before the tip, it widens to form a broad tooth on the lateral side, the tip of which is finely dentate. The tip of this apophysis is narrow, rounded and incurved. The paracymbium is strongly curved,

without a distinct notch before the tip. The bezel broad and straight across the edge. Tail-piece of the embolic division relatively small, the tip curved around toward the edge of the cymbium. The terminal part consists of a long, stout, black style which is curved in a circle around the tip of the bulb and is accompanied by a membranous conductor.

Female. Length, 2.5 mm. Similar to male in form and color. Epigynum has the middle lobe rather broad and light colored, the hind margin is slightly raised and in the middle there is a slightly raised protuberance.

Type locality: Mt. Washington, N. H.

New York: Artist's Brook, Chapel Pond, Essex Co., June 28, 1923, 1 ♂ 1 ♀. Sifted from moss on rocks forming ice caves under which the ice persists throughout the year; Wilmington Notch, Aug. 26, 1921, 1 ♀.

Alberta: Sulphur Mt., Banff, Aug. 2, 1927, 1 ♂.

Wyoming: Grand Canyon, Yellowstone Nat. Park, Aug. 30, 1927, 1 ♂.

Cornicularia communis Emerton
(Figures 24–26)

Cornicularia communis Emerton. Conn. Acad. Sci. Trans. 6: 41, pl. 11, fig. 3. 1882.

Lophocarenum arvense Banks. Phila. Acad. Nat. Sci. Proc. 1892, p. 37, pl. 4, fig. 11.

Prosopotheca communis Simon. Hist. Nat. Ar. 1: 626, 1894.

Prosopotheca communis Crosby. Phila. Acad. Nat. Sci. Proc. 1905, p. 330.

Male. Length, 2.5 mm. Cephalothorax orange, slightly suffused with dusky on the head; viewed from above rather elongate, evenly rounded on the sides of the thorax, slightly constricted at the cervical groove, then with the sides strongly convergent but with the outline distinctly convex; viewed from the side, steeply ascending behind and then gradually to the posterior eyes with a very slight broad depression at the cervical groove. The median ocular area occupied by a large stout blunt horn the tip of which is densely clothed with short erect hairs. The lower horn is very small and closely applied to the upper one. Clypeus nearly vertical, concave.

Posterior eyes in a procurved line, the median separated by a little more than the diameter and from the lateral by the diameter. Anterior eyes in a straight line, the median much smaller than the lateral, separated by the radius and from the lateral by a little more.

Sternum, labium, and endites dusky orange, legs lighter. Abdomen dark gray. Palpus indistinguishable from that of *directa.*

Female. Length, 2.5 to 3 mm. Cephalothorax orange, the head varying from light dusky to nearly black. Legs yellow or orange, dusky distally. Palpus with the tibia and tarsus dark.

Posterior eyes in a slightly procurved line, the median separated by the radius and from the lateral by a little more. Anterior eyes in a slightly recurved line, the median smaller than the lateral, almost touching, separated from the lateral by the radius. Epigynum indistinguishable from that of *directa.*

Type localities: Mt. Washington, N. H., eastern Massachusetts and New Haven, Conn.

New York: Mt. Whiteface, Aug. 24, 1916, 1 ♀; Freeville, Oct. 12, 1924, 2 ♂, 4 ♀; McLean, May 16, 1925, 8 ♀; May 14, 1919, 2 ♀; May 30, 1921, 3 ♀; May 8, 1919, 1 ♀; June 21, 1924, 2 ♀; Danby, Oct. 17, 1924, 1 ♂; West Barre, Sept. 19, 1925, 1 ♂; Mt. Marcy, Aug. 27, 1930, 1 ♂; Olcott, April 10, 1919, 1 ♀ (Stout and Dietrich); Labrador Pond, June 25, 1922, 1 ♀; Long Pond, Suffolk Co., June 29, 1924, 1 ♀; Pinekill, Sullivan Co., May 11, 1922, 1 ♀; Lockport, Nov. 1918, 1 ♀.

Massachusetts: Mt. Greylock, Oct. 2, 1927, 1 ♀.

Illinois: Brownsville, June 8, 1926, 1 ♀ (Smith).

New Jersey: Ramsey, 1 ♂ 1 ♀ (Emerton det.).

Cornicularia directa Cambridge

(Figures 27–33)

Erigone directa Cambridge. Zool. Soc. London Proc. 1874, p. 439, pl. 55, fig. 9.

Erigone provida Cambridge. Zool. Soc. London Proc. 1875, p. 398, pl. 46, fig. 5.

Cornicularia directa Emerton. Conn. Acad. Sci. Trans. 6: 40, pl. 11, fig. 1. 1882.

Lophocarenum miniatum Banks. Phila. Acad. Nat. Sci. Proc. 1892, p. 36, pl. 4, fig. 4.

Lophocarenum longior Banks. Phila. Acad. Nat. Sci. Proc. 1892, p. 38, pl. 4, fig. 12.

Prosopotheca directa Simon. Hist. Nat. Ar. 1: 626. 1894.

Cornicularia directa Emerton. Common Spiders, p. 152, figs. 374–376. 1902.

Prosopotheca directa Crosby. Phila. Acad. Nat. Sci. Proc. 1905, p. 330.

Cornicularia directa Banks. Phila. Acad. Nat. Sci. Proc. 1916, p. 73.

Male. Length, 2.5 mm. Cephalothorax chestnut brown; viewed from above rather elongate, evenly rounded on the sides with a slight constriction at the cervical groove; viewed from the side rather steeply ascending behind then gradually ascending to the posterior eyes with a slight and broad depression at the cervical groove. Clypeus somewhat retreating, gently concave. The median ocular area occupied by a large horn which is longer and more slender than in *communis* and is clothed the whole length on the upper side with reflexed hairs. The lower horn larger and the cleft between the horns deeper than in *communis*.

Posterior eyes in a procurved line, the median separated by a little less than the diameter and from the lateral by the diameter. Anterior eyes in a straight line, the median smaller than the lateral, separated by less than the radius and from the lateral by the radius.

Sternum and labium chestnut brown, endites yellowish. Legs and palpi yellow. Abdomen dark gray.

Femur of palpus slightly broader distally, gently curved inward; patella nearly straight, thicker distally. Ratio of length of femur to that of patella as 20 to 8. Tibia short, dorsally produced into a long, pointed, incurved apophysis which is separated by a deep evenly rounded notch from the shorter and blunter dorso-lateral apophysis. The lateral margin of the dorsal apophysis excavated, forming a very deep groove. Paracymbium very strongly curved with a small hook at tip. The tail-piece of the embolic division thin, pointed, curved in

an irregular spiral. The terminal part arises directly from the tail-piece with which it forms a right angle. It then makes one small complete flat turn around the end of the bulb.

Female. Length, 2.5 mm. Differs from female of *communis* in having cephalothorax and sternum chestnut brown and the terminal segments of the palpus are not dusky. The epigynum has the middle lobe broad and bounded in front by a curved ridge.

New York: Mt. Mac Intyre, July 1, 1921 (4,000 ft.), 1 ♀; Charley Lake, Hamilton Co., Apr. 27, 1923, 1 ♀; Wilmington Notch, Aug. 29, 1921, 2 ♂; Wells, Apr. 27, 1923, 1 ♀; Paul Smith's, Aug. 30, 1927, 1 ♂ (P. J. Chapman); Meredith, May 19, 1923, 1 ♂; McLean, May 16, 1925, 6 ♂; Apr. 24. 1924, 2 ♂ 1 ♀; Ithaca, April 29, 1921, 2 ♀; Apr. 10, 1926, 1 ♂; Nov. 26, 1915, 1 ♂ 1 ♀ (S. A. Graham); Apr. 9, 1922, 2 ♂; Jan., 1 ♀; Oct. 8, 1922, 1 ♂; Nov. 19, 1925, 1 ♂ 1 ♀; Oct. 1906, 1 ♂; Interlaken, Nov. 25, 1915, 1 ♀ (Ping); Ringwood, Tompkins Co., May 20, 1919, 1 ♂ (H. Dietrich); Shurgers Glen, Tompkins Co., Nov. 24, 1918, 1 ♂; Connecticut Hill, Tompkins Co., Oct. 1924, 1 ♂; Michigan Mills, Lewis Co., Sept. 1, 1926, 2 ♂; Barrington, Oct. 27, 1918, 1 ♂; Penn Yan, May 4, 1922, 2 ♂ 3 ♀; Guyanoga, June 24, 1923, 1 ♀; Lake Keuka, Dec. 1905, 1 ♂ 1 ♀; Eglestons Glen, Yates Co., Sept. 24, 1920, 1 ♂ 1 ♀; Italy Hill, Oct. 27, 1918, 1 ♂; Stow, Sept. 17, 1925, 1 ♂ 1 ♀; Karners, Mar. 24, 1923, 4 ♂ 1 ♀; Oakland Valley, May 26, 1920, 2 ♂; Sterlington, May 18, 1924, 1 ♂ 1 ♀; Pinekill, Sullivan Co., May 11, 1922, 2 ♂ 1 ♀; Savona, Sept. 25, 1920, 2 ♀; Northville, Apr. 21, 1923, 1 ♂; Presho, Oct. 29, 1924, 1 ♀; Mountain Lake, Fulton Co., Apr. 26, 1923, 1 ♂.

Pennsylvania: Potters Mills, Oct. 31, 1924, 2 ♂ 2 ♀.

Massachusetts: Boston 1 ♀.

North Carolina: Mt. Pisgah, Frying Pan Gap, Oct. 13, 1926, 1 ♂; Wayah Bald, Oct. 16, 1926, 1 ♂; Highlands, Apr. 5, 1929, 2 ♂ 1 ♀.

Illinois: Salts, May 19, 1926, 1 ♀ (V. G. Smith).

Maine: Molunkus Pond, Aug. 25, 1925, 1 ♂ 1 ♀.

Tennessee: Mt. Le Conte, Oct. 10, 1926, 1 ♂ 3 ♀.

Cornicularia indirecta Cambridge
(Figures 34–36)

Erigone indirecta Cambridge. Zool. Soc. Lond. Proc. 1874, p. 440, pl. 55, fig. 10.

Cornicularia indirecta Emerton. Conn. Acad. Sci. Trans. 6: 41, pl. 11, fig. 4, 1882.

Erigone indirecta Keyserling. Spinnen. Am. Therid. 2: 146, pl. 16, fig. 213. 1886.

Prosopotheca indirecta Simon. Hist. Nat. Ar. 1: 626. 1894.

Male. Length, 2.5 mm. Cephalothorax reddish orange, the whole head chestnut brown; viewed from above elongate, evenly rounded on the sides to the cervical groove where there is a slight constriction in front of which the outline is again slightly convex; viewed from the side gradually ascending behind with a broad shallow depression at the cervical groove, then nearly level to the posterior eyes. The horn rather blunt and strongly elevated, noticeably roughened at the base above, the lower member closely applied to the upper. Both parts are shorter and thicker than in *directa.*

Posterior eyes in a very strongly procurved line, equal, the median separated by three times the radius and from the lateral by twice the diameter. Anterior eyes in a recurved line, equal, the median separated by the radius and a little farther from the lateral.

Sternum dusky reddish orange, smooth. Cheliceræ, endites, and labium chestnut brown. Legs orange, lighter distally. Abdomen yellow. Clypeus retreating, convex below the eyes and concave near the margin.

Palpus practically the same as in *directa.*

Female. Length, 2.5 mm. Similar to male in form and color. Posterior eyes in a very slightly procurved line, nearly equal, the median separated by a little less than the diameter and from the lateral by the diameter. Anterior eyes in a very slightly recurved line, the median a little smaller than the lateral, subcontiguous, separated from the lateral by the radius.

The epigynum transverse; the middle lobe broader than long, the posterior margin straight; the margins of the openings well chitinized.

Type locality: None given, but as Cambridge received his specimens from Emerson, probably New England.

New Hampshire: Tyngsboro, Feb. 1 ♂ 1 ♀ (Emerton).

The specimen in the Cornell University collection which Banks recorded as *indirecta* in Phila. Acad. Nat. Sci. Proc. 1892, p. 34, is *Ceratinopsis laticeps* Em.

Cornicularia minuta Emerton
(Figures 37–42)

Cornicularia minuta Emerton. Conn. Acad. Sci. Trans. 6: 42, pl. 11, fig. 6, 1882.

Erigone paullula, Marx. Catalogue p. 535. 1890.

Prosopotheca minuta, Simon. Hist. Nat. Ar. 1: 626. 1894.

Male. Length, 1.1 mm. Cephalothorax dusky yellow, darker at margin; head the same color. Cephalothorax viewed from above rather broad, evenly rounded on the sides to the cervical groove where there is no constriction, then very slightly narrowed towards the front, broadly rounded across the front; viewed from the side rather steeply ascending behind, then level to the posterior eyes. Clypeus almost vertical, slightly concave below the eyes.

Posterior eyes in a slightly procurved line, the median separated by a little more than the diameter and from the lateral by the radius. Anterior eyes in a straight line, the median smaller than the lateral, subcontiguous, separated from the lateral by the diameter. The horn is single and consists of a low hump shallowly grooved above.

Sternum light orange yellow, smooth and shining. Endites yellow, lighter distally. Legs orange yellow. Abdomen dark gray.

Femur of palpus straight, the same thickness throughout; patella moderately thickened distally; tibia short and armed dorsally with a very long, pointed process which curves laterally over the base of the cymbium, the mesal side angulate at the middle; on the lateral side of this process there is a very deep, rounded notch which is bounded laterally by a triangular lobe, the upper edge of which is straight and armed with very dense stiff black hairs. The paracymbium is strongly curved and with

a small hook at the tip. Tail-piece of the embolic division thin and pointed, making a sharp angle with the middle part, the terminal part, or embolus proper, arises as a rather broad flat rod, but rapidly becomes more slender and makes one flat turn around the end of the bulb.

Type localities: Mt. Carmel, Hamden, Conn., and Mt. Washington, N. H.

New York: High Falls, Essex Co., Aug. 26, 1921, 2 ♂; Lake Bluff, Sept. 19, 1920, 1 ♂; Riverhead, April 11, 1923, 1 ♂; Baiting Hollow, April 8, 1924, 1 ♂; Penn Yan, May 30, 1922, 1 ♂; Amagansett, May 24, 1924, 1 ♂.

New Jersey: Montclair, April 5, 1930, 1 ♂ (Hayden).

Minnesota: Lake Minnetonka, Sept. 1925, 1 ♂ 2 ♀ (Fletcher).

Missouri: Columbia, Mar. 1906, 1 ♂ 1 ♀.

Cornicularia pallida Emerton
(Figures 43–48)

Cornicularia pallida Emerton. Conn. Acad. Sci. Trans. 6: 42, pl. 11, fig. 7. 1882.

Erigone humiliceps Keyserling. Spinn. Am. Therid. 2: 148, pl 16, fig. 214. 1886.

Prosopotheca pallida Simon. Hist. Nat. Ar. 1: 626. 1894.

Male. Length, 2.6 mm. Cephalothorax dusky reddish orange, darker on the head; viewed from above evenly rounded on the sides, slightly constricted at the cervical groove and then gradually tapering towards the front; viewed from the side, evenly arched over the back to the posterior eyes with a slight depression at the cervical groove. Clypeus almost straight and slightly retreating. Horn double, the lower element very small and not shown in Emerton's figure. Horn viewed from the side appears as a bluntly triangular hump clothed above on the sides with stiff recurved hairs. Posterior eyes in a strongly procurved line, equal, the median separated by a little less than the diameter and from the lateral by the diameter. Anterior eyes in a straight line, equal, the median subcontignous and separated from the lateral by the radius.

Sternum bright orange, slightly roughened. Labium and endites brownish yellow. Legs yellow. Abdomen yellowish white.

Femur of palpus nearly straight; patella moderately long, slightly widened distally. Tibia very similar to that of *directa* as is also the palpal organ.

Female. Length, 2 mm. Similar to male in form and color. The epigynum similar to *communis* and *directa* but has the middle lobe broader.

Type locality: New Haven, Conn.

New York: Auger Pond, Essex Co., Nov. 17, 1916, 1 ♂ (Emerton det.); Ithaca, Nov., 2 ♂; Penn Yan, Nov. 10, 1928, 1 ♂; Staten Island, Feb. 22, 1913, 2 ♂ 1 ♀, A. M. N. H; Northville, Apr. 27, 1923, 1 ♀.

Rhode Island: Kingston, June 1905, 1 ♀ (Barlow).

District of Columbia: Washington, April 2 ♂ 2 ♀ (Fox). taken in sifting, Sept.–Nov. 1 ♂ 1 ♀ (Fox).

North Carolina: Blowing Rock, Oct. 10, 1923, 3 ♀; Raleigh, Oct. 26, 1923, 1 ♂.

Kentucky: Quicksand, June 25, 1925, 2 ♀.

Missouri: Mansfield, Oct. 1905. 1 ♂.

Cornicularia placida Banks

Cornicularia placida Banks. Phila. Acad. Nat. Sci. Proc. 1892, p. 35, pl. 5, fig. 36.

Cornicularia placida Crosby. Same. 1905, p. 308.

Cornicularia placida Banks. Same. 1916, p. 72, pl. 11, fig. 19.

Described from female only. Banks states that this is probably the female of some described species. He is doubtless correct.

Cornicularia tibialis Emerton

(Figures 49–51)

Cornicularia tibialis Emerton. Conn. Acad. Sci. Trans. 6: 41, pl. 11, fig. 2, 1882.

Prosopotheca tibialis Simon. Hist. Nat. Ar. 1: 626. 1894.

Male. Length, 2 mm. Cephalothorax chestnut brown; viewed from above evenly rounded on the sides to the cervical groove where there is a very slight constriction, broadly rounded across the front; viewed from the side ascending gradually in a straight line, then rounding to the posterior eyes with a slight depression at the cervical groove. Clypeus concave and slightly

retreating. The horn arising from the median ocular area is higher and more slender than in *tumida* and projects farther above the head; it is double and clothed on the top with short, stiff, recurved hairs.

Posterior eyes in a very slightly procurved line, the median slightly smaller than the lateral, separated by the radius and a little farther from the lateral. Anterior eyes in a straight line, median smaller than the lateral, nearly touching, a little farther from the lateral. The anterior median eyes dark, the lateral light.

Sternum dusky orange, labium and endites the same but lighter distally. Legs orange. Abdomen greenish gray.

Femur of palpus moderately long and slender. Patella short and slightly widened distally. Ratio of length of femur to that of patella as 14 to 6. The tibia of the same general form as in *tumida* but dorsal apophysis when viewed from the lateral side is more strongly bent at the middle and clothed at the bend with stronger granulations. The bulb itself strongly resembles that of *tumida*.

In the naturally expanded bulb, the embolus lies in the lateral concavity of the tibial apophysis, next to the dentate margin. The paracymbium apparently lies against the base of the tail-piece of the embolic division, holding the tip of the embolus in place.

Type locality: Mt. Tom, Holyoke, Mass.

New Jersey: Lakehurst, May 1, 1912, 1 ♂ (Emerton det.).

District of Columbia: Washington, Mar. 12, 1925, 1 ♂ (H. C. Barber).

Cornicularia tumida n. sp.

(Figures 52–56)

Male. Length, 1.4 mm. Cephalothorax dusky orange yellow; viewed from above evenly rounded on the sides to the cervical groove and then slightly narrowing to the front, the horn slightly projecting beyond the clypeus; viewed from the side steeply ascending behind and then rounded over to the eyes. A short, blunt, flat-tipped double horn arises from the median ocular area, the groove separating the two parts of the horn shallow.

Top of horn clothed with short recurved hairs. Clypeus concave and slightly retreating.

Posterior eyes in a slightly procurved line, the median separated by the radius and a little farther from the lateral. Anterior eyes in a very slightly procurved line, subcontiguous, the median very little smaller than the lateral. All the eyes light colored.

Sternum orange yellow, sparsely clothed with dark hairs, labium and endites lighter. Legs yellowish tinged with orange, abdomen pale, dirty white.

Femur of palpus moderately slender. Patella short, widened distally. Ratio of length of femur to that of patella as 12 to 5. Tibia short on the ventral side but dorsally prolonged into a long, pointed apophysis which is deeply grooved within and has the lateral margin armed with a series of small, sharp, black teeth. At the base of this process on the mesal side there is a blunt, triangular tooth. Paracymbium rather slender, very strongly curved with a short hook at tip. Tegulum is strongly developed and covers a large part of the face of the bulb; the tail-piece of the embolic division thin, and spirally curved, merging without a break into the embolus proper which is spirally curved in one compact turn, the tip lying near the long, slender, pointed, median apophysis.

The species can be distinguished from *tibailis* by its smaller size, lighter color of thorax and abdomen, by having all the eyes light colored, while in *tibialis* the anterior median are dark, and by the form of the tibial apophysis of the male palpus. Closely resembles *pallida* in the shape of the cephalic horn and in color, except that the head is not noticeably darker in *tumida* and *pallida* lacks the denticulate lateral margin of the tibial apophysis.

Holotype male, Little Pond, Orange Co., New York, May 25, 1920, 1 ♂. Sifting sphagnum.

PARACORNICULARIA new genus

Type: *P. bicapillata*, n. sp.

Related to Cornicularia and Ceratinopsis in the structure of the palpal organ. The form of the embolic division seems to approach more closely to Ceratinopsis. The patella of the male palpus is greatly elongate. The cephalic horn of Cornicularia is replaced by a slight protuberance from which arise two stiff forward directed hairs.

Paracornicularia bicapillata new species
(Figures 57–62)

Male. Length, 1.1 mm. Cephalothorax yellowish, slightly dusky especially along the margin; viewed from above rather long broadly rounded on the sides posteriorly, slightly constricted at the cervical groove, broad and squarely truncate in front, rounded on the corners; viewed from the side, steeply ascending behind, flat on top to just above the anterior median eyes where it turns squarely downward. Clypeus gently concave and slightly protruding. Just above the anterior median eyes there is a small tubercle bearing two very long stiff straight hairs that project straight in front. A median row of three black hairs curved forward on the head.

Posterior eyes in a slightly procurved line, equal, median separated by a little more than the diameter and a little closer to the lateral. Anterior eyes in a procurved line, the median smaller than the lateral, subcontiguous, and separated from the lateral by about the diameter. Clypeus a little wider than the median ocular area.

Sternum yellowish, slightly dusky, strongly convex, produced in a truncated point between the hind coxæ which are separated by the diameter. Labium and endites yellowish tinged with orange. Chelicera dusky yellow with a few small black tubercles on the face. Legs and palpi pale yellowish. Anterior tibia armed dorsally with a regular series of curved stiff hairs. Abdomen light reddish over yellow.

Femur of palpus long and slender, slightly curved. Patella stout, widened distally. Ratio of length of femur to that of patella as 4 to 3. Tibia slender at base, widened distally; on the dorso-lateral angle there is a broad rounded notch; the dorsal margin evenly rounded, on the mesal margin there is a basally broad, apically narrow and strongly curved apophysis, the tip directed dorsally. The paracymbium is rather slender at the base and very strongly curved and hooked. The bezel broad, pointed toward the tip of the palpus. Tail-piece of the embolic division thin and flat, widened at tip and extending over the edge of the cymbium. The terminal part of the embolus spirally curved in a semi-circle, rather broad and bluntly pointed at tip. The ejaculatory duct is on the outside of the curve but opens at the middle of the tip.

Female. Length, 1.3 mm. Another female is 1.6 mm. long. Similar to male in form and color. Viewed from the side the head is not so square in front, the clypeus slightly more protruding. The series of curved hairs on the anterior tibia not present.

Epigynum has the middle lobe broadly and evenly rounded behind. The ducts of the spermathecæ show distally as widely separated oval dark spots divergent behind.

Holotype male, allotype female and 1 female paratype, Columbia, Missouri, November.

Mississippi: Starkville, Dec. 24, 1924, 1 ♂ (J. W. Bailey).

TIGELLINUS Simon

Ar. Fr. 5: 838. 1884.

Type: *Phalops furcillatus* Menge.

This genus is related to Cornicularia in the structure of the palpal organ but the posterior median eyes of the male are borne on a separate lobe.

Tigellinus tricornis Emerton

(Figures 63–66)

Cornicularia tricornis Emerton. Conn. Acad. Sci. Trans. 6: 43, pl. 11, fig. 8, 1882.

Tigellinus tricornis Simon. Hist. Nat. Ar. 1: 626. 1894.

Tigellinus tricornis Crosby. Phila. Acad. Nat. Sci. Proc. 1905, p. 308.

Male. Length, 1.9 mm. Cephalothorax dark brown, not much darker toward the head; viewed from above elongate oval, the margin slightly crenulate at the radiating lines (possibly due to the age of the specimen), slightly constricted at the cervical groove and broadly rounded across the front; viewed from the side rather steeply ascending behind, then nearly straight to the cervical groove and rounded over the head to the base of the horn. According to Emerton the posterior median eyes are borne on the base of the dorsal horn which is branched in front and separated from the rest of the head and the lower horn by a very deep fissure which reaches back under the posterior median eyes. The lower horn is short, bluntly rounded and clothed at the tip with a cluster of short recurved hairs. Clypeus almost vertical, slightly concave below the eyes.

Posterior eyes according to Emerton's figure in a slightly recurved line. In the specimen before us these eyes have been injured so that their relation to the lateral cannot be determined. Anterior eyes in a slightly recurved line, equal, the median separated by less than the radius and from the lateral by about the radius. Sternum, labium, and endites dark brownish. Legs orange. Abdomen dark gray or black.

Femur of palpus cylindrical, bent strongly inward at base. Patella short and slightly thickened distally. Ratio of length of femur to that of patella as 17 to 7. Tibia short below but

above produced into a long, broad, process which at the base, mesally, is widened into a triangular tooth, laterally there is a broad rounded emargination near the base beyond which there is a broad triangular tooth, tip thin and rounded. Paracymbium rather small, strongly curved. Tail-piece of the embolic division slender and extending to the edge of the tegulum. Terminal part of the embolic division consists of a basally stout black style curved in a circle forming one turn around the tip of the bulb.

Type locality: Mt. Washington, N. H.

New Hampshire: Mt. Washington, June, 1877, 1 ♂ (Emerton).

This is one of the specimens from which the original description was drawn.

WALCKENÆRA Blackwall

London and Edinb. Phil. Mag. (Ser. 3) 3: 106, 1833.

Type: *W. acuminata* Blackwall.

This genus is represented in the United States by only one species, *vigilax* Blackwall, which also occurs in Europe. *W. vigilax* differs from the type of the genus in having the head of the male strictly normal but is closely related to it in the form of the palpal organ. We follow de Lessert, Bösenberg, and Chyzer and Kulczynski in placing it in Walckenæra. For comparison we give four views of the palpus of *W. acuminata* (Figures 67–70).

Walckenaera vigilax Blackwall

(Figures 71–75)

Neriene vigilax Blackwall. Ann. Mag. Nat. Hist. (Ser. 2) 11: 24, 120. 1853.

Neriene vigilax Blackwall. Spid. Gt. Brit. p. 277, pl. 19, fig. 191. 1864.

Erigone vigilax Thorell. Rem. Syn. Europ. Spid. p. 446. 1873.

Neriene vigilax Cambridge. Spiders of Dorset p. 113. 1879–81.

Spiropalpus spiralis Emerton. Conn. Acad. Sci. Trans. 6: 39, pl. 10, fig. 6. 1882.

Cornicularia vigilax Simon. Ar. Fr. 5: 848, figs. 783, 784. 1884.

Lophomma vigilax Dahl. Schriften naturw. Ver. f. Schleswig-Holstein, 6: 98. 1886.

Cornicularia vigilax Simon. Hist. Nat. Ar. 1: 627. 1894.

Walckenæra vigilax Chyzer and Kulczynski. Araneæ Hungariæ 2: 146, pl. 5, fig. 30. 1894.

Walckenæra vigilax Bösenberg. Spinnen Deutschlands, p. 144, pl. 13, fig. 191. 1903.

Prosopotheca spiralis Crosby. Phila. Acad. Nat. Sci. Proc. 1905, p. 332.

Cornicularia vigilax Falconer. Naturalist, p. 332. 1909.

Walckenæra (Cornicularia) vigilas de Lessert. Cat. Ar. Suisse p. 181. 1910.

Cornicularia vigilax Simon. Ar. Fr. 6: 418. 1826.

Spiropalpus spiralis Simon. Ar. Fr. 6: 509. 1826.

Male. Length, 2 mm. Cephalothorax dusky orange with darker radiating lines; viewed from above rounded on the sides with scarcely any depression at the cervical groove, broadly rounded across the front; viewed from the side ascending rather steeply in a straight line to the cervical groove where there is a very shallow depression, then ascending at the same angle to the top of the head which is higher than the posterior eyes, rounded over the top of the head.

Posterior eyes in a slightly procurved line, the median slightly larger than the lateral, all eyes equidistant and separated by a little less than the diameter. Anterior eyes in a straight line, the median smaller than the lateral, separated by a radius and from the lateral by a little more.

Sternum dark gray over orange, endites and labium pale yellowish. Legs and palpi pale orange yellow. Abdomen very dark gray, almost black.

Femur of palpus cylindrical, slightly curved inward. Patella as thick as femur, curved downward. Ratio of length of femur to that of patella as 15 to 7. Tibia short and provided with a long, dorsal, laterally curved apophysis which is narrow basally, widened distally and deeply grooved on the lateral side. The tip is thin and lies close to cymbium. Between the base of this apophysis and the angulate margin of the tibia there is a deep rounded emargination. Paracymbium rather small, sharply hooked at tip. Tail-piece of the embolic division rather small, broad at base and slender at tip, nearly straight. Terminal part of embolic division consists of a very long, slender, black style which is coiled twice around the tip of the bulb.

Type locality: Denbigshire, Wales.

New Hampshire: Hollis, Aug. 1888 3 ♂ (Fox).

New York: Louck's Pond, Steuben Co., July 5, 1924, 1 ♂; Ithaca, Aug. 1 ♂; Aug. 4, 1916, 1 ♂; Oct. 1 ♂; Sept. 18, 1 ♂; Nov. 2 ♂; Aug. 1903, 1 ♂; Olcott, Feb. 1925, 2 ♂ 1 ♀ (Henry Dietrich); McLean, May 30, 1921, 1 ♂; June 21, 1924, 2 ♂; Prattsburg, July 16, 1926, 1 ♂; Cinnamon Lake, Schuyler Co., June 5, 1925, 1 ♂; July 12, 1924, 1 ♂.

Georgia: Billy's Island, Okefinokee Swamp, June 1912, 2 ♂; Mixon's Hammock, Okefinokee Swamp, June 16, 1912, 1 ♂.

Illinois: Salts, July 3, 1926, 1 ♂ (Smith).

Missouri: Columbia, Sept. 20, 1925, 1 ♂; June 1905, 3 ♂; Hunter, Aug. 1905, 1 ♂.

District of Columbia: Washington, July 12, 1925, 1 ♂ (H. S. Barber); May 1 ♂ (Fox).

Virginia: East Falls Church, June 30, 1926, 1 ♂.

Ohio: Gambier, June 15, 1905, 1 ♂ (Nelson).

France: E. Simon's collection 1 ♂.

EPICERATICELUS new genus

Type: *E. fuvialis* n. sp.

This genus is related to *Ceraticelus* and *Ceratinella* in the form of the tail-piece of the embolic division of the genital bulb but differs from it in the form of the embolus in which there is no break before the tip. There are no hardened sclerites on the abdomen as in those genera. It is related to Cornicularia but the tibial armature is not of the type found in that genus.

Epiceraticelus fluvialis new species

(Figures 76–79)

Male. Length, 1.1 mm. Cephalothorax dull orange yellow with a light spot in front of the cervical groove; viewed from above rounded on the sides, no constriction at the cervical groove, broadly rounded across the front; viewed from the side steeply ascending to the cervical groove and then evenly rounded to the eyes. Clypeus slightly concave below the eyes and then slants forward.

Posterior eyes in a straight line, equal, the median separated a little less than the diameter and from the lateral by the radius. Anterior eyes in a slightly recurved line, the median much smaller than the lateral, sub-contiguous and separated from the lateral by about the radius.

Sternum broad and convex, yellow, produced in a truncate point between the hind coxæ. Labium and endites dull orange. Legs orange yellow. Abdomen dull grayish yellow.

Femur of palpus slender, thicker distally and slightly curved inward. Patella short and rather thick. Ratio of length of femur to that of patella as 11 to 5. Tibia diagonally truncate, very short beneath and dorsally produced into a long, thin process which is hollowed out beneath to form a groove. At the base of the apophysis, on the lateral side, there is a distinct rounded notch. Paracymbium rather broad, flat and strongly curved. Bezel high, the upper edge nearly straight. Tail-piece of the embolic division long, narrow, and slightly curved toward tip, reaching to the edge of the cymbium, much as in Ceraticelus. The terminal part of the embolic division consists of a rather stout, black style which makes one turn around the end of the bulb. The coil is not circular but triangular with rounded corners. The style does not lie flat but undulates.

Female. Length, 1.2 mm. Similar but the abdomen is lighter in color. The epigynum has a middle lobe which is straight behind and which is overlapped in front by a bluntly triangular lobe.

Holotype male, allotype female, Riverhead, N. Y.

New York: Riverhead, April 11, 1923, 5 ♂ 11 ♀; May 31, 1923, 1 ♂ 1 ♀; Pomona, Rockland Co., April 12, 1923, 1 ♀.

PELECOPSIS Simon

Hist. Nat. Ar. Ed. 1, p. 196. 1864.

Type. *Micryphantes inaequalis* C. L. Koch, 1841 (*Theridion elongatum* Wider, 1834).

Simon established Pelecopsis as a sub-genus of Micryphantus Koch, placing only one species under it. In his later work Simon ignored Pelecopsis and placed its type and other related species in Lophocarenum Menge (1868). Smith, F. P. (Jour. Quekett Microscopical Club Ser. 2, Vol. 9, No. 58, Apr. 1906) seems to have been the first to revive Simon's name for the group.

In Pelecopsis, as here used, the abdomen, at least in the male, bears a hardened dorsal plate, the head of the male is strongly elevated into a cephalic lobe bearing the posterior median eyes, and cephalic pits are present. The embolus is of the spiral type with a very long tail-piece. In the structure of the embolic division *moestum* Banks differs somewhat from the typical forms but it seems best, for the present at least, to leave it here.

The generic position of *Lophocarenum rugosum* Emerton is uncertain but it is not related to Pelecopsis. As pointed out by Emerton it is closely related to *Lophocarenum Latum* Em. and *L. cretatum* Em. but lacks the cephalic pits.

Lophocarenum frontalis Banks is excluded from this genus because the cephalic lobe bears all the eyes.

Pelecopsis sculptum Emerton

(Figures 80–85)

Lophocarenum sculptum Emerton. Can. Ent. 49: 261, fig. 12, 1917.

Male. Length, 2 mm. Cephalothorax brown with darker radiating lines. Viewed from the side rounded over the back to the base of the median lobe of the head which is very high. The back of the lobe ascends at a steep angle and it is rounded over the top and slightly retreating in front to a point just above the lateral eyes where the outline slopes forward gradually to the anterior median eyes. Clypeus convex.. The cephalic pits are very large and deep and lie close above and behind the posterior lateral eyes. The posterior median eyes are borne on the front of the top of the median lobe which has a deep groove over the top so that each eye is on a separate division of the lobe.

Posterior eyes in a strongly procurved line, the median widely separated and more remote from the lateral than from each other. Anterior eyes in a gently procurved line, the median nearer to each other than to the lateral. Just above the anterior median eyes there is a group of short stiff hairs parted in the middle.

Sternum blackish brown, darker on the edge, the margin scalloped opposite the coxae. Hind coxae separated by a little less than the length. Labium same color as sternum. Endites light brownish yellow suffused with gray. Legs and palpi orange yellow.

Dorsum of abdomen covered with a dark brown sclerite which is densely and coarsely sculptured. Epigastric sclerite not well developed consisting of two lunate plates connected by three transverse bands. Inframammillary sclerite well developed but of irregularly outline anteriorly. Soft parts of abdomen dark gray.

Femur of palpus rather stout, slightly thicker distally, patella straight and rather stout. Ratio of length of femur to that of patella as 19 to 9.

Tibia armed with a broad dorsal apophysis which is obliquely truncate at apex and with a deep rounded emargination laterally. Tail-piece of the embolic division short and straight, the tip lying on the edge of the tegulum, which on this side is black. The embolus is black, stout at base, narrowing gradually to the tip and curved in an open spiral of one turn. The tip lies near the tip of the cymbium.

Female. Length, 2.5 mm. Similar to male in coloration. Cephalothorax viewed from the side rather steeply ascending behind with a broad shallow depression at the cervical groove, rounded over the head with the median ocular area slanting at 45 degrees. Clypeus slightly convex, nearly vertical.

Posterior eyes in a procurved line, about equidistant. Anterior eyes in a straight line, the median close together but well separated from the lateral. Dorsal abdominal sclerite smaller than in male, extending back only about two-thirds the length of the abdomen. Epigastric sclerite only very slightly developed. Inframammillary sclerite a narrow yellow transverse plate in front of spinnerets. Epigynum, figure 85.

Type locality: Metlakatla, B. C.

Redescribed from the types, 1 ♂ and 1 ♀, Metlakatla B. C.

Washington: Friday Harbor, June–July, 1928, 5 ♂ 6 ♀ (Shackleford); Friday Harbor, Aug. 5, 1926; 1 ♀ (Worley).

Pelecopsis excavatum Emerton

(Figures 86–91)

Lophocarenum excavatum Emerton. Conn. Acad. Sci. Trans. 16: 391, pl. 2, fig. 3, 1911.

Lophocarenum minakianum Emerton. Can. Ent. 51: 105, pl. 7, fig. 1. 1919.

Male. Length, 1.7 mm. Cephalothorax reddish orange with the cephalic lobe yellow orange, viewed from above rather broad, rounded on the sides, the sides convergent towards the front, rounded truncate in front; viewed from the side, the posterior declivity ascending in a straight line, then slightly hollowed back of the base of the very large cephalic lobe. The latter high

and bearing the posterior median eyes on the top; viewed from the side, nearly perpendicular and gently rounded behind, rounded over the top and down in front to the transverse groove. This groove is deep and at the sides reaches the edge of the very large cephalic pits. Below the groove the head projects forward some distance in front of the cephalic lobe. Clypeus perpendicular and slightly concave.

Posterior eyes in a procurved line; the median separated by three times the diameter and borne on the top of the cephalic lobe in front of its middle, widely separated from the lateral. Anterior eyes in a procurved line, the median much smaller than the lateral, separated by about the radius and from the lateral by more than the diameter. Chelicerae orange yellow, rather stout, vertical; the claw with a single curve.

Sternum broad with scalloped margin, convex, smooth, shining, sparsely and shallowly punctate, reddish orange, blackish at margin, produced between the hind coxæ in an inflexed and truncate point. Posterior coxæ separated by a little less than the length. Labium blackish. Endites yellow orange like the legs and palpi.

Abdomen almost completely covered with a strongly chitinized, dark reddish orange sclerite, shallowly but rather densely punctate. Epigastric sclerite strongly developed, the posterior angles rounded and narrowly connected back of the furrow. In front of the opening of the reproductive organs there is semi-circular area of soft integument containing a small free transverse, lenticular sclerite. Circummamillary sclerite widest below where it extends far in front of the spiracular furrow. Soft parts of abdomen grayish, thickly studded with minute brownish punctures each bearing a short pale hair.

Femur and patella of palpus of nearly equal length, nearly straight and slightly compressed. Tibia short; the dorsal apophysis triangular, acute, with the tip slightly incurved, the lateral margin minutely granulate. Paracymbium small, slender and curved in a semi-circle. Bezel strongly developed; the opposite edge of the tegulum strongly chitinized and appearing as a conspicuous curved plate just inside of which lies the tail-piece of the embolic division. The tail-piece is elongate, gently

curved and the tip extends beyond the edge of the tegulum. The apical part is black and curved in a short spiral of one turn. The ejaculatory duct opens just before the tip. The median apophysis appears as a conspicuous, black, rather slender process lying laterally from the tip of the embolus.

Female. Length, 1.9 mm. Similar to the male in color. The head is rather high but not elevated as in the male and the abdomen does not have a dorsal sclerite. The cephalothorax is dark reddish brown, lighter on the head, marked with rows of punctures along the radiating furrows and a strongly curved row extending backward from the outside of each posterior median eye.

The posterior eyes in a procurved line, nearly equal and equidistant, the median separated by the diameter. Anterior eyes in a procurved line, the median much smaller than the lateral, separated by less than the radius and from the lateral by less than the diameter.

The epigynum is a nearly circular convex plate near the posterior edge of which there are indications of two oval openings.

Type locality: Ipswich, Mass.

New York: Summit of Mt. Whiteface, Aug. 25, 1922, 5 ♂ 1 ♀. Sifting moss.

Massachusetts: Ipswich, Aug. 18, 1908, 1 ♂ 1 ♀ (Emerton). Paratypes. Under straw on the edge of the salt marsh.

Ontario: Minaki. (Emerton.) Types of *L. minakianum* Em.

This species is very closely related to *Lophocarenum parallelum* Wider of Europe.

Pelecopsis moestum Banks

(Figures 92–97)

Ceratinella moesta Banks. Phila. Acad. Nat. Sci. Proc. 1892, p. 32, pl. 2, fig. 58, pl. 5, fig. 58.

Lophocarenum moestum Crosby. Phila. Acad. Nat. Sci. Proc. 1905, p. 301.

Lophocarenum coriaceum Emerton. Conn. Acad. Sci. Trans. 18: 215, pl. 1, fig. 10. 1913.

Male. Length, 1.6 mm. Cephalothorax dark reddish brown, lighter on the cephalic lobe, the surface rugose especially on the

side; viewed from above rather broad, evenly rounded on the sides to the cervical groove where there is a slight constriction, from there the sides are gently curved but strongly converging with the front narrow, rounded; viewed from the side rather strongly arched over the back to the cervical groove. The cephalic lobe narrow, very high in profile, evenly rounded behind to the posterior median eyes, in front convex, nearly vertical. The cephalic pits, small, round, and situated in distinct grooves. Clypeus wide and strongly convex.

Posterior eyes in a straight line, the median on the front of the top of the cephalic lobe, separated by two thirds the diameter and from the lateral eyes by more than twice the diameter. Anterior eyes in a very slightly procurved line, the median smaller than the lateral, separated by less than the radius and from the lateral by the diameter.

Sternum convex, dark orange red, rugose, the ridges blackish. Coxal cavities closed by lateral prolongations of the sternum. Endites lighter and smoother. Posterior coxæ separated by the length.

Abdomen viewed from above broadly oval, somewhat pointed behind; viewed from the side high in front, perfectly flat above as if cut off, convex below. Ventral sclerite dark reddish orange, finely rugose, very strongly developed into one piece covering the whole under surface and extending up in front above the pedicel, and also on the sides so that its edge is visible from above. Behind it surrounds the spinnerets. The soft integument of the abdomen is confined to the upper surface occupying an oval area bounded by the edge of the ventral sclerite and bearing in front the broadly oval, dull reddish dorsal sclerite which is finely rugulose. Legs reddish orange yellow, patellæ pale.

Femur of palpus rather stout, slightly curved inward. Patella moderately arched above. Ratio of length of femur to that of patella as 15 to 7. Tibia longer than patella, gradually widened distally, the dorsal margin produced over the base of the cymbium in a broad evenly rounded lobe with a rounded notch on the outer angle. Paracymbium broad at base, short, strongly hooked at tip. Bezel wide and high, the edge bent around the

embolus. The embolic division consists of a flat, thin, curved tail-piece which extends over the edge of the tegulum. The embolus is very short and ends in two points; the first is rather blunt and bears the opening of the ejaculatory duct, the other is curved and ends in a shap point. The median apophysis appears as a thin round-pointed process with a sharp tooth on the outer side some distance from the tip.

Female. Length, 1.6 mm. Similar to the male in coloration. Cephalothorax viewed from the side rounded over the thorax with a distinct depression at the cervical groove; head rather high, rounded over the back to the posterior eyes.

Posterior eyes in a gently procurved line, the median less than the diameter apart, a little farther from the lateral. Anterior eyes in a slightly procurved line, the median smaller than the lateral, separated by much less than the radius and from the lateral by the radius. Clypeus wide, slightly concave above, somewhat protruding. The last two segments of the palpi long and somewhat enlarged.

Hard parts of abdomen reddish brown, soft parts greenish. Epigastric sclerite large and strongly chitinized, rugose, extending about half way from the epigynum to the spinnerets; it surrounds the pedicel and extends up on the front of the abdomen so as to be visible from above. In front of the epigynum there is a crescentic area of soft integument and behind it there is a smaller lunate greenish area containing the two muscle impressions. Inframamillary sclerite broad, extending around the spinnerets as a narrow ring above. Dorsal sclerite distinct, rounded on the sides, truncate in front and behind, much narrower than abdomen and extending only about half way back.

Epigynum a transverse oval plate. The middle lobe broad and short, not raised above the general level of the plate.

Type locality: Ithaca, N. Y.

New York: Ithaca, South Hill beyond [south of] Buttermilk Creek, Nov. 1 ♂ (Banks); Pine Island, Orange Co., May 19, 1920. 1 ♀

Connecticut: Danbury, July 19, 1912. ♂ ♀ (Emerton). Types of *L. coriaceum*.

Ohio: Rockridge, May 17, 1925. 3 ♂ (Barrows).

North Carolina: Black Mts., N. Fork Swannanoa River, ♂ ♀ (Banks).

Kentucky: Quicksand, June 25, 1925. 1 ♀.

Mississippi: Richton, Dec. 8, 1930. 1 ♂ (H. Dietrich); Mar. 23, 1931. 1 ♀; Lucedale, Mar. 1931, 1 ♂, 2 ♀ (Dietrich).

PLATE XXV

1. Cornicularia auranticeps, ♂ cephalothorax, dorsal view.
2. Cornicularia auranticeps, ♂ cephalothorax, lateral view.
3. Cornicularia auranticeps, ♂ tibia, dorsal view.
4. Cornicularia auranticeps, ♂ right palpus, lateral view.
5. Cornicularia auranticeps, ♀ epigynum.
6. Cornicularia breviaria, ♂ cephalothorax, dorsal view.
7. Cornicularia breviaria, ♂ cephalothorax, lateral view.
8. Cornicularia brevicula, ♂ cephalothorax, dorsal view.
9. Cornicularia brevicula, ♂ cephalothorax, lateral view.
10. Cornicularia brevicula, ♂ left palpus, dorsal view.
11. Cornicularia brevicula, ♂ left palpus, lateral view.

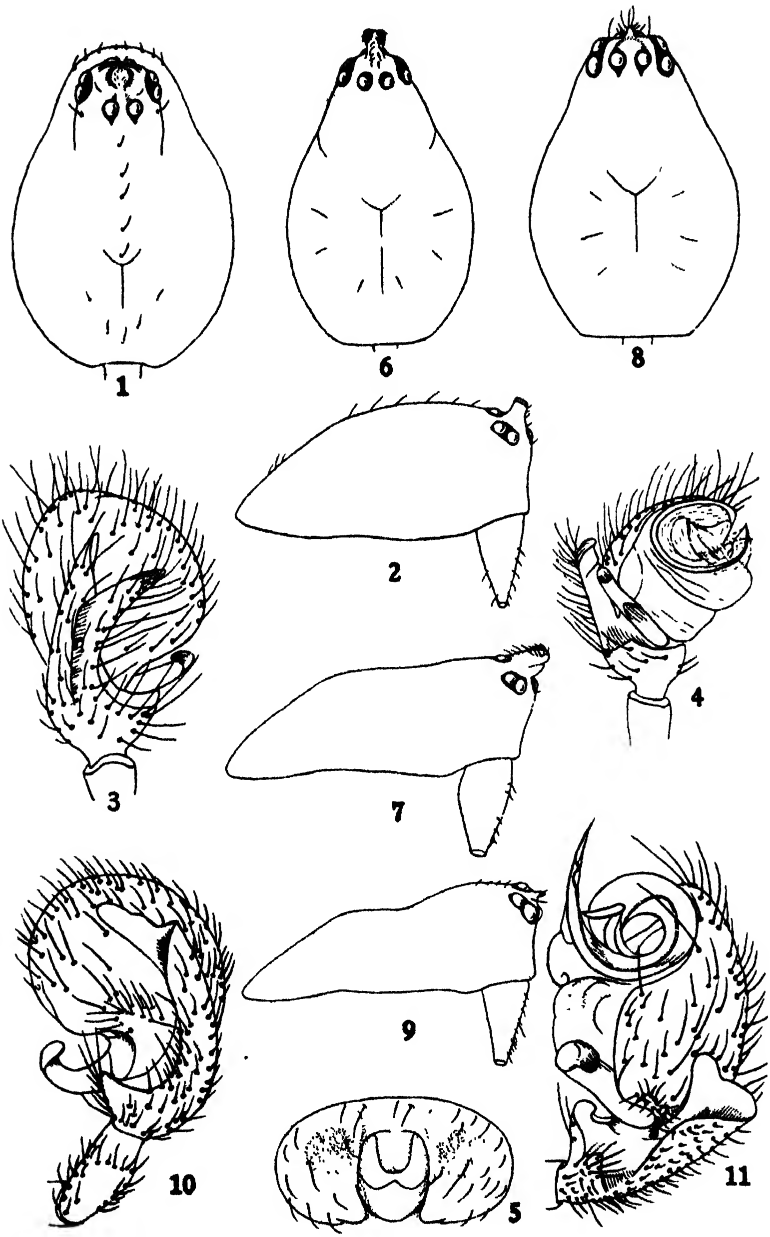
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PLATE XXVI

12. Cornicularia brevicornis, ♂ right palpus, dorsal view.
13. Cornicularia brevicornis, ♂ right palpus, lateral view.
14. Cornicularia brevicornis, ♂ right palpus, meso-ventral view.
15. Cornicularia brevicornis, ♂ cephalothorax, dorsal view.
16. Cornicularia brevicornis, ♂ cephalothorax, lateral view.
17. Cornicularia brevicornis, ♀ epigynum.
18. Cornicularia clavicornis, ♂ right palpus, dorsal view.
19. Cornicularia clavicornis, ♂ right palpus, mesal view.
20. Cornicularia clavicornis, ♂ right palpus, lateral view.
21. Cornicularia clavicornis, ♂ cephalothorax, dorsal view.
22. Cornicularia clavicornis, ♂ cephalothorax, lateral view.
23. Cornicularia clavicornis, ♀ epigynum.

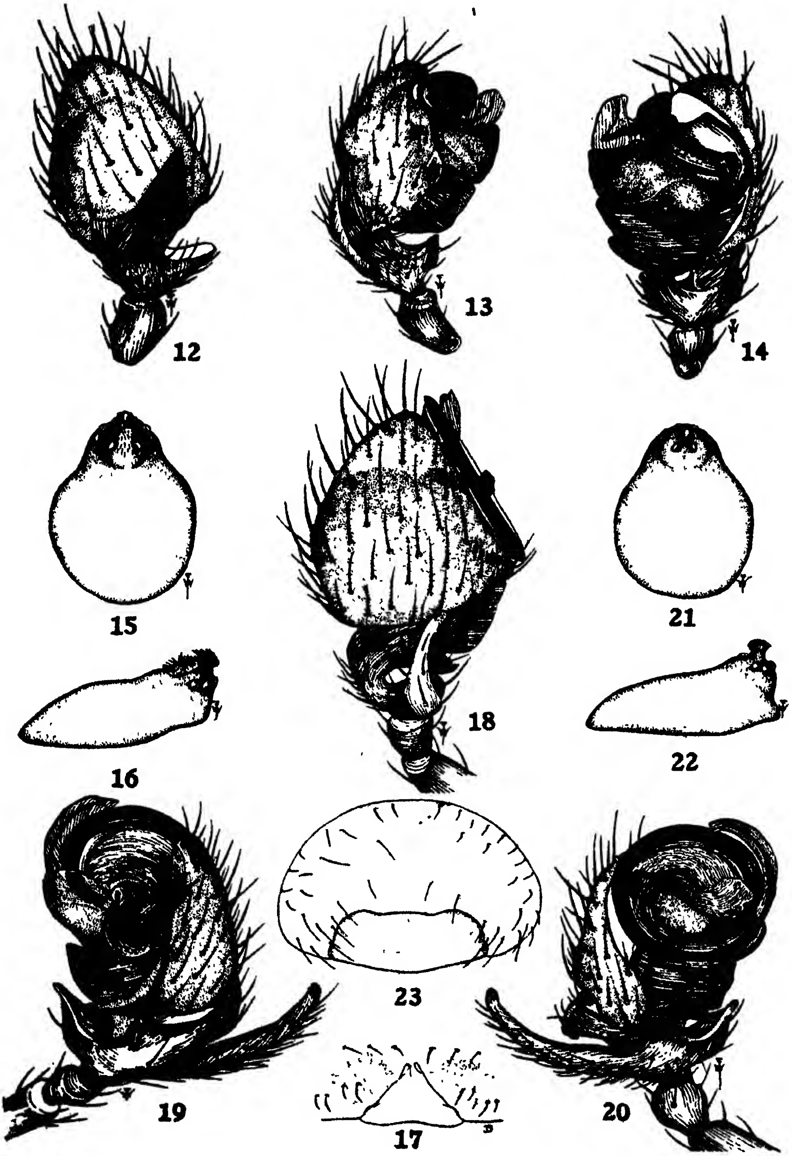
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PLATE XXVII

24. Cornicularia communis, ♂ cephalothorax, dorsal view.
25. Cornicularia communis, ♂ cephalothorax, lateral view.
26. Cornicularia communis, ♀ epigynum.
27. Cornicularia directa, ♂ cephalothorax, dorsal view.
28. Cornicularia directa, ♂ cephalothorax, lateral view.
29. Cornicularia directa, ♂ right palpus, lateral view.
30. Cornicularia directa, ♂ right palpus, mesal view.
31. Cornicularia directa, ♂ right palpus, ventral view.
32. Cornicularia directa, ♂ right palpus, dorsal view.
33. Cornicularia directa, ♀ epigynum.
34. Cornicularia indirecta, ♂ cephalothorax, dorsal view.
35. Cornicularia indirecta, ♂ cephalothorax, lateral view.
36. Cornicularia indirecta, ♀ epigynum.

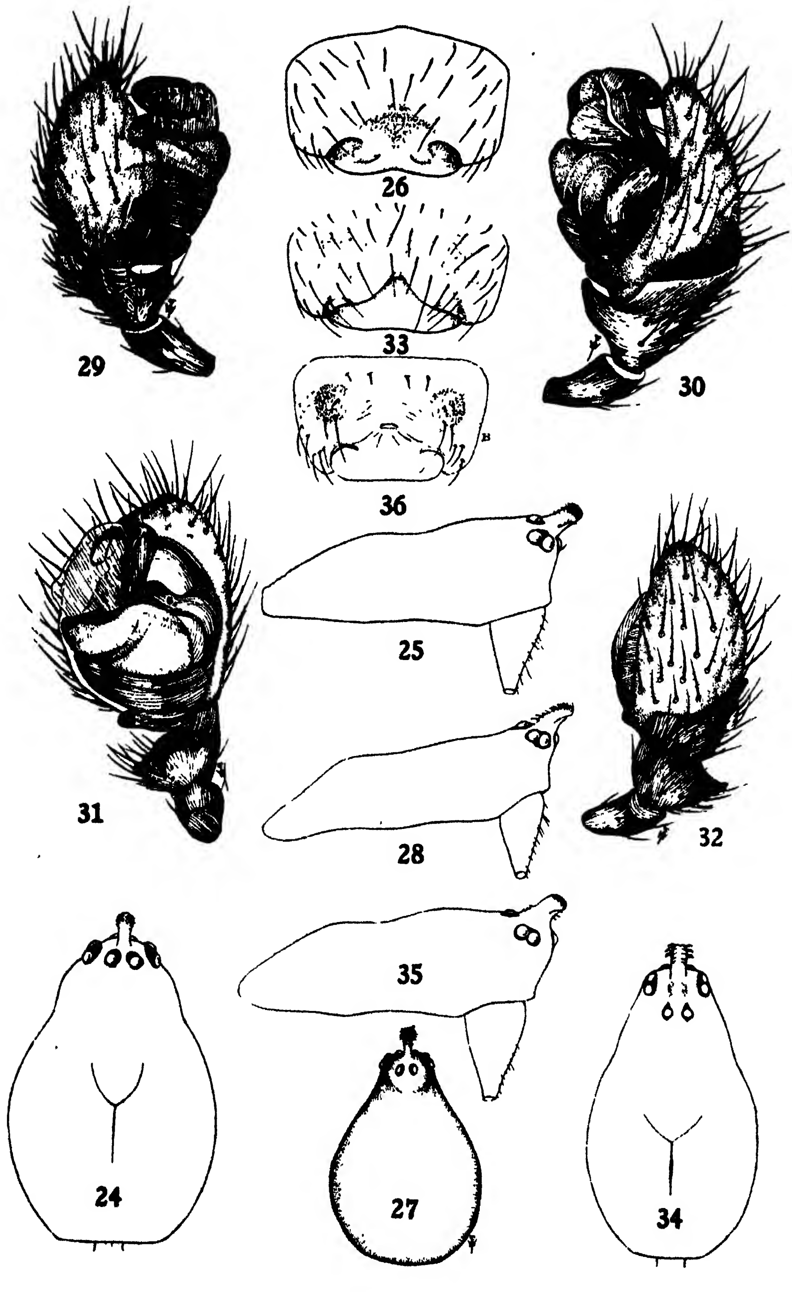
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PLATE XXVIII

37. Cornicularia minuta, ♂ cephalothorax, dorsal view.
38. Cornicularia minuta, ♂ cephalothorax, lateral view.
39. Cornicularia minuta, ♂ right palpus, dorsal view.
40. Cornicularia minuta, ♂ right palpus, mesal view.
41. Cornicularia minuta, ♂ right palpus, lateral view.
42. Cornicularia minuta, ♀ epigynum.
43. Cornicularia pallida, ♂ cephalothorax, dorsal view.
44. Cornicularia pallida, ♂ cephalothorax, lateral view.
45. Cornicularia pallida, ♂ right palpus, dorsal view.
46. Cornicularia pallida, ♂ right palpus, mesal view.
47. Cornicularia pallida, ♂ right palpus, lateral view.
48. Cornicularia pallida, ♀ epigynum.
49. Cornicularia tibialis, ♂ cephalothorax, dorsal view.
50. Cornicularia tibialis, ♂ cephalothorax, lateral view.
51. Cornicularia tibialis, ♂ dorsal view.

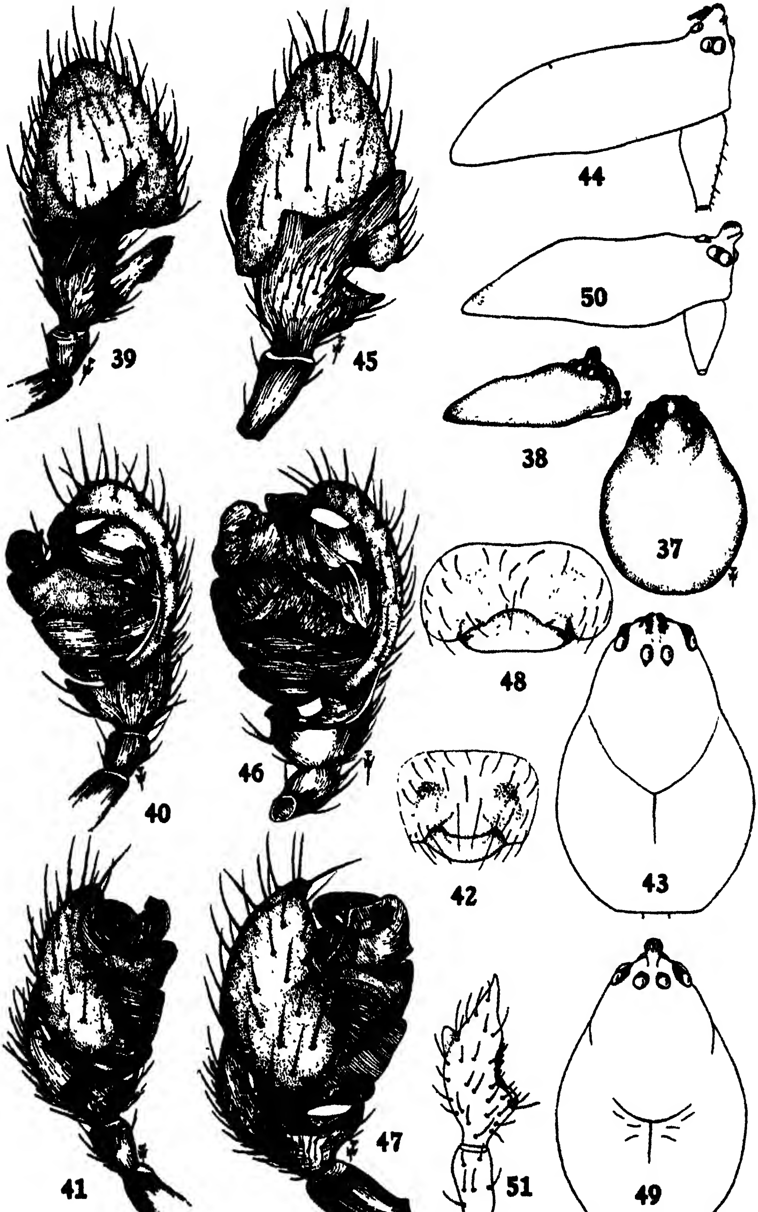
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PLATE XXIX

52. Cornicularia tumida, ♂ cephalothorax, dorsal view.
53. Cornicularia tumida, ♂ cephalothorax, lateral view.
54. Cornicularia tumida, ♂ right palpus, dorsal view.
55. Cornicularia tumida, ♂ right palpus, lateral view.
56. Cornicularia tumida, ♂ right palpus, ventral view.
57. Paracornicularia bicapillata, ♂ cephalothorax, dorsal view.
58. Paracornicularia bicapillata, ♂ cephalothorax, lateral view.
59. Paracornicularia bicapillata, ♂ right palpus, ventral view.
60. Paracornicularia bicapillata, ♂ right palpus, lateral view.
61. Paracornicularia bicapillata, ♂ right palpus, mesal view.
62. Paracornicularia bicapillata, ♀ epigynum.
63. Tigellinus tricornis, ♂ head, dorsal view (after Emerton).
64. Tigellinus tricornis, ♂ head, lateral view (after Emerton).
65. Tigellinus tricornis, ♂ right palpus, dorsal view.
66. Tigellinus tricornis, ♂ right palpus, lateral view.

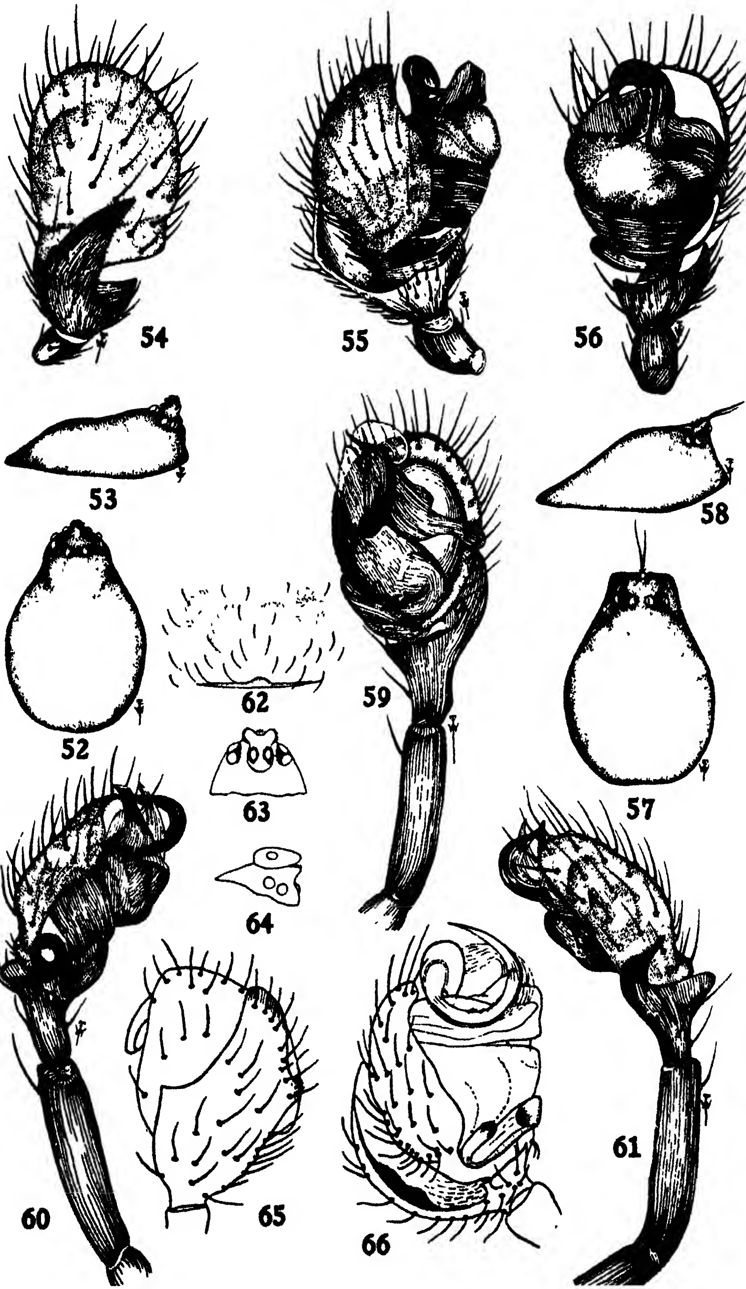
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PLATE XXX

67. Walckenaera acuminata, ♂ right palpus, dorsal view.
68. Walckenaera acuminata, ♂ right palpus, lateral view.
69. Walckenaera acuminata, ♂ right palpus, ventral view.
70. Walckenaera acuminata, ♂ right palpus, mesal view.
71. Walckenaera vigilax, ♂ cephalothorax, lateral view.
72. Walckenaera vigilax, ♂ right palpus, dorso-lateral view.
73. Walckenaera vigilax, ♂ right palpus, ventral view.
74. Walckenaera vigilax, ♂ right palpus, mesal view.
75. Walckenaera vigilax, ♀ epigynum.

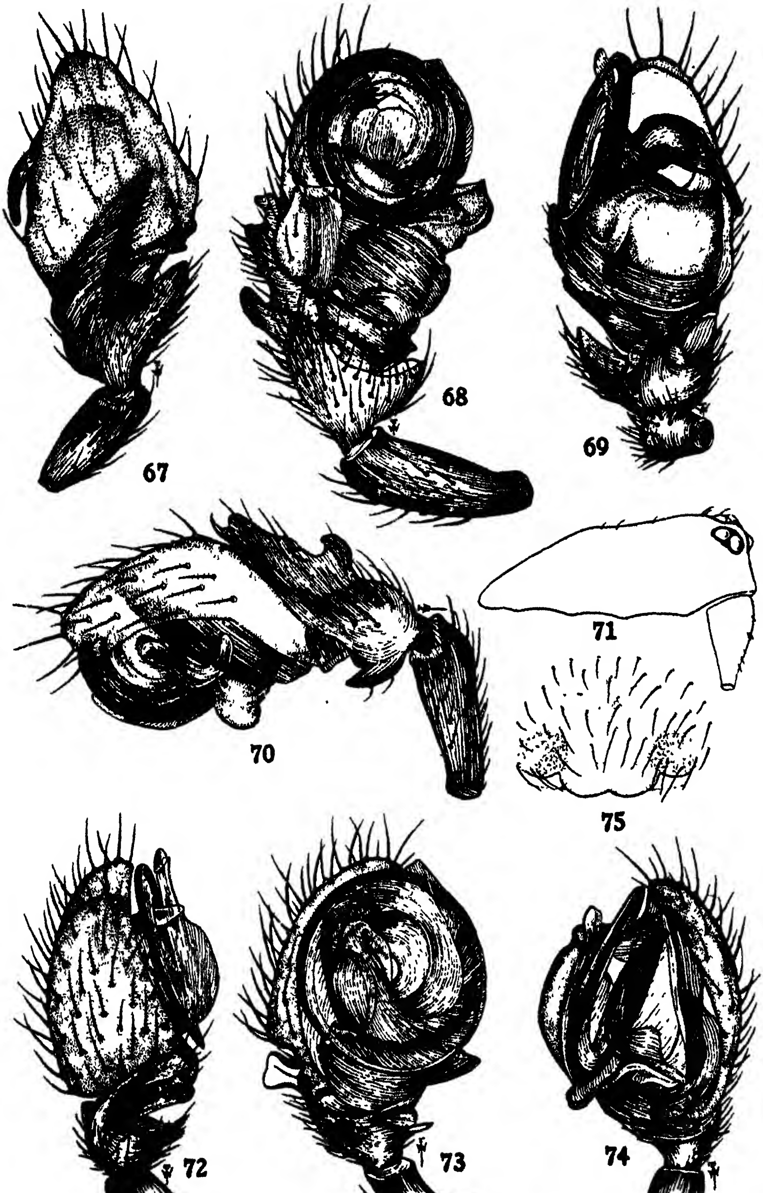
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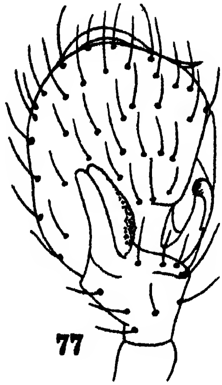
PLATE XXXI

76. Epiceraticelus fluvialis, ♂ cephalothorax, lateral view.
77. Epiceraticelus fluvialis, ♂ right palpus, dorsal view.
78. Epiceraticelus fluvialis, ♂ right palpus, lateral view.
79. Epiceraticelus fluvialis, ♀ epigynum.
80. Pelecopsis sculptum, ♂ cephalothorax, dorsal view.
81. Pelecopsis sculptum, ♂ cephalothorax, lateral view.
82. Pelecopsis sculptum, ♂ right palpus, dorsal view.
83. Pelecopsis sculptum, ♂ right palpus, lateral view.
84. Pelecopsis sculptum, ♂ right palpus, mesal view.
85. Pelecopsis sculptum, ♀ epigynum.
86. Pelecopsis excavatum, ♂ cephalothorax, dorsal view.
87. Pelecopsis excavatum, ♂ cephalothorax, lateral view.
88. Pelecopsis excavatum, ♀ epigynum.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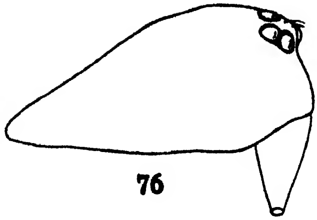
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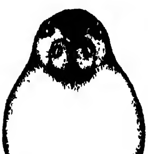
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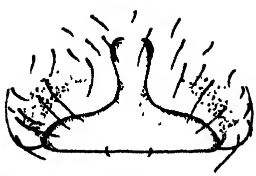
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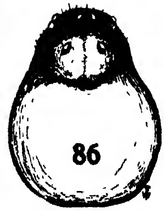
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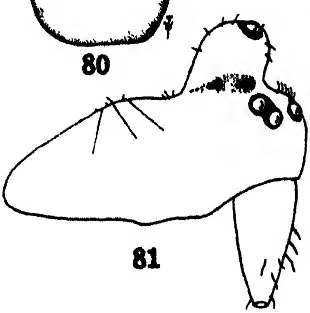
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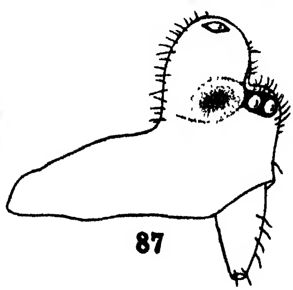
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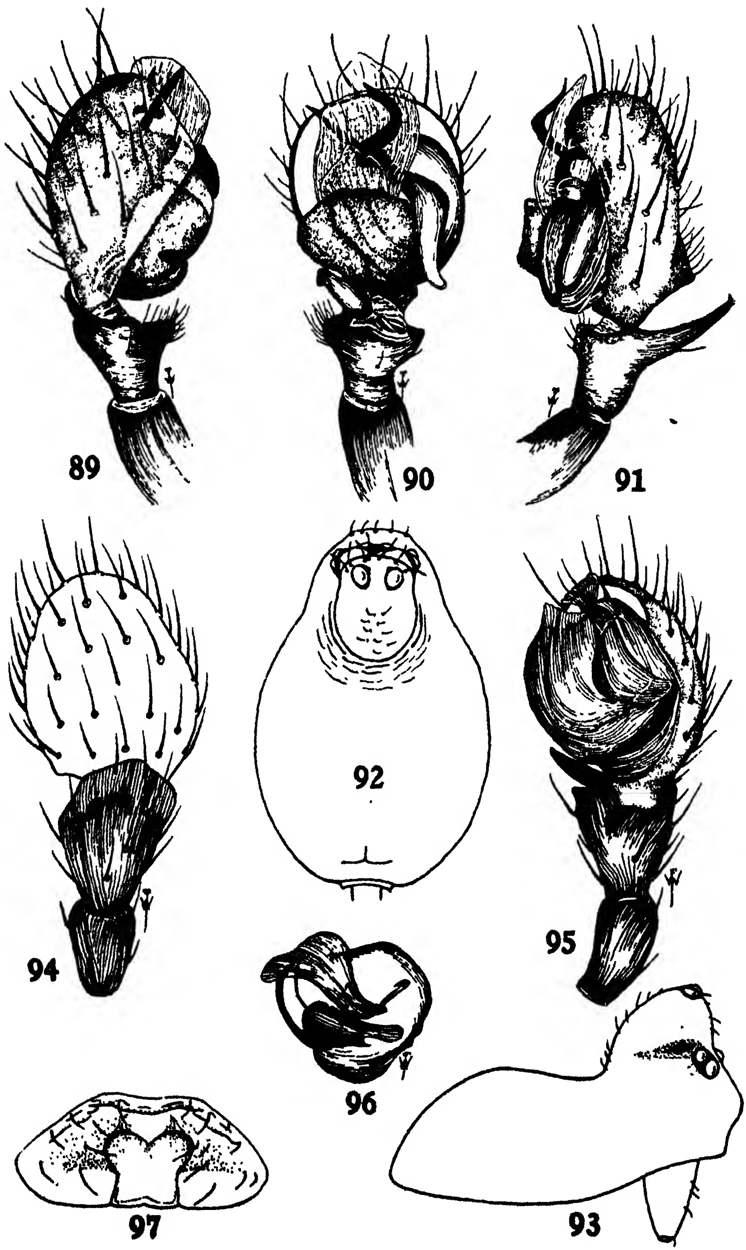
PLATE XXXII

89. Pelecopsis excavatum, ♂ right palpus, lateral view.
90. Pelecopsis excavatum, ♂ right palpus, ventral view.
91. Pelecopsis excavatum, ♂ right palpus, mesal view.
92. Pelecopsis moestum, ♂ cephalothorax, dorsal view.
93. Pelecopsis moestum, ♂ cephalothorax, lateral view.
94. Pelecopsis moestum, ♂ right palpus, dorsal view.
95. Pelecopsis moestum, ♂ right palpus, meso-ventral view.
96. Pelecopsis moestum, ♂ right palpus, embolic division and tegulum.
97. Pelecopsis moestum, ♀ epigynum.

The preparation of many of the drawings, by Albert W. Force, of Ithaca, N. Y. and Miss Helen Zorsch, of Rochester, N. Y., was made possible by a grant from the Heckscher Research Foundation at Cornell University.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THE AFFINITIES OF HOLCORPA MACULOSA SCUDDER AND OTHER TERTIARY MECOPTERA, WITH DESCRIPTIONS OF NEW GENERA

BY F. M. CARPENTER*
MUSEUM OF COMPARATIVE ZOOLOGY

In 1878, one year after the discovery of insects in the Florissant shales of Colorado, Scudder described from that formation a large and well preserved scorpion-fly, *Holcorpa maculosa*, belonging to the family Panorpidæ. He realized that the insect was a close relative of Panorpa, but believed that it differed from the members of that genus by the total absence of cross-veins in the wings. He also thought that the specimen was a male with a long, slender abdomen, although the genital bulb on the terminal segment was not preserved. In 1926 Professor T. D. A. Cockerell published a rough sketch of another specimen of this insect in his "Zoology of Colorado," showing the whole abdomen, head, and other parts which invited further study and which indicated that a detailed description of this new fossil was very desirable. Professor Junius Henderson, curator of the Natural History Museum at the University of Colorado, kindly forwarded the specimen to me for this purpose and I am indebted to him, as well as to Professor Cockerell, for the opportunity of investigating the affinities of this remarkable insect.

Scudder's type specimen of *Holcorpa maculosa*, which is now at the Museum of Comparative Zoology, shows clearly the color pattern of the wings and the details of the venation. Under proper illumination and magnification the cross-veins in the apical region of the wings can easily be seen, although Scudder was unable to discern them and designated their supposed absence as the distinctive characteristic of the genus Holcorpa. The type fossil is not a male, as Scudder thought; the abdomen is slender and tapering, as in all female Panorpidæ, and is utterly different from that of the male which Professor Cockerell secured. The new fossil is one of the most perfectly preserved Florissant insects which I have seen (Fig. 1). The two right wings are spread out, showing with surprising clearness the color

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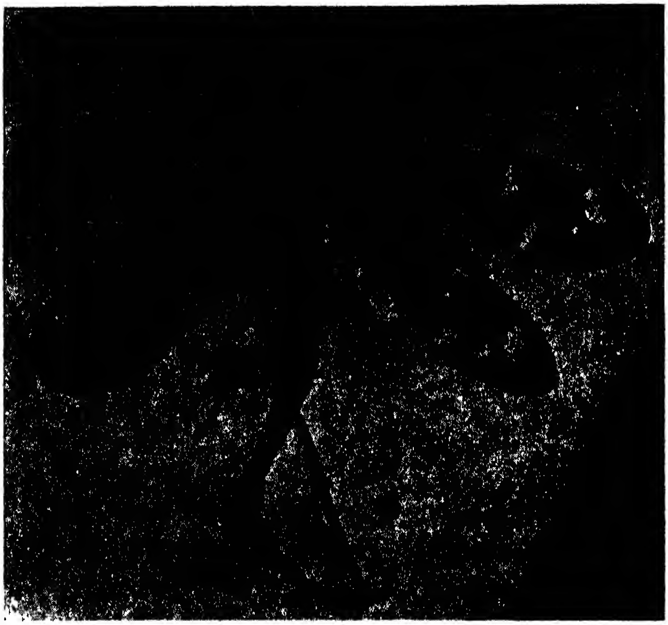


FIG. 1. Photograph of allotype of *Holcorpa maculosa* Scud. (×2).

markings, venation, and even the microtrichia on the wing membrane. The entire body, including antennæ, rostrum, legs, and many details of the genital bulb, is preserved. This complete preservation enables us to fix accurately the characteristics of Holcorpa and to form a more definite conception of the affinities of the genus with existing groups.

Genus *Holcorpa* Scudder

Holcorpa Scudder, 1878, Bull. U. S. Geol. Surv. Terr., 4: 542
1890, Tert. Ins. N. Amer., 174

Allied to Leptopanorpa and Neopanorpa. Rostrum long and slender; antennæ slender, with about forty segments; sixth, seventh, and eighth abdominal segments greatly modified and elongate; genital bulb large; Sc terminating on the costal margin; Rs with six branches in both pairs of wings; M with five branches in both wings; 1A long, extending beyond the origin of Rs.

Genotype: *Holcorpa maculosa* Scudder.

Holcorpa maculosa Scudder
(Plate XXXIII)

Holcorpa maculosa Scudder, 1878, Bull. U. S. Geol. Surv. Terr., 4: 542
Scudder, 1883, Ann. Rep. U. S. Geol. Surv. Terr., 12: 283
Scudder, 1885. In Zittel's Handb. Paleont., 1 (2): 778, fig. 984
Scudder, 1886, In Zittel-Barrois' Traité de Paleont., 2: 778, fig. 1001
Scudder, 1890, Tert. Ins. N. Amer.: 174–175; pl. 14, fig. 4, 5
Handlirsch, 1908, Foss. Ins.: 911

♂. Fore wing: length, 21 mm.; width, 6 mm. Hind wing: length, 18 mm.; width, 5 mm. Length of whole insect, 55 mm. Wing membrane dark brown or possibly black distally, hyaline basally; three large, irregular hyaline spots along the anterior margin, and three smaller ones near the posterior border, all in the distal half of the wings; sixth abdominal segment slender, about three times as long as the fifth and bearing posteriorly a pair of long horns, similar to those of *Neopanorpa cornuta* Esben-Petersen, but much larger; seventh segment about as long as the sixth and even more slender; eighth segment about one and one-half times as long as the seventh and a little more slender; posteriorly, at the junction with the genital bulb, the eighth segment is slightly swollen; genital bulb large, the basal part twice as long as wide; the forceps are longer than the rest of the bulb and are very slender and straight, without the basal tooth.

♀. Fore wing: length, 19 mm.; width, 5 mm. Hind wing: length, 17 mm.; width, 5 mm. Length of body, 30 mm. Wing markings similar to those of male; abdomen tapering, unusually long; the segmentation of the abdomen is not clear in the fossil.

Holotype (♀): No. 247, Museum of Comparative Zoology (collected by Mrs. Fisher).

Allotype, by present designation: No. 4494, University of Colorado, Natural History Museum (collected by Geo. N. Rohwer at Station 14).

There are several features of this insect which deserve comment. The general habitus of the male, which is by far the most important sex for taxonomic purposes, is shown in the photograph, figure 1. The terminal abdominal segments are directed anteriorly, and cross over the base of the preceding segment, indicating that at the time of its death the insect held the end of its abdomen in the usual panorpid position, curved upwards and over the rest of the abdomen. The head is turned sidewise to the left and is preserved in a lateral view. The tenuity of the sixth, seventh, and eighth abdominal segments of the insect is remarkable, for only one recent panorpid, *Leptopanorpa longicauda* Weele (Java) has a habitus at all comparable; but in this species the sixth segment is the longest and the eighth is the shortest of the three, the reverse of the condition in *Holcorpa maculosa.* The pair of horns on the posterior end of the sixth abdominal segment is another bizarre feature. As shown in the photograph, the seventh segment arises between these two horns. Only one existing panorpid, *Neopanorpa cornuta,* has similar structures and here the horns are very short and blunt; all other panorpids possess either a single median or none at all. The genital bulb is a well developed structure and the elongate forceps are unique among the Panorpidæ, but find their nearest approach among some of the Neopanorpas. The wing markings are more like those of certain Neopanorpas (*e.g., ocellaris* Navas) than those of Panorpa. It is certain that no Mecopteron related to Holcorpa exists in North America at the present time, and this statement also applies to South America, for the subfamily Panorpinæ has not been found there. In so far as the body structure is concerned it is nearest to Neopanorpa and perhaps Leptopanorpa, although both of these genera are restricted to the Old World, the former to Java, Borneo, and associated regions, and the latter to this same area and Japan. The presence of a member of the Panorpidæ in Colorado during the Miocene is not very surprising, even though the family extends in North America only a little west of the Mississippi River at the present time; but that this representative should show closest affinities with Old World genera, rather than our own, is most interesting. From a survey of the body structure of Holcorpa,—its

long rostrum, and extreme modification of the abdomen,—we are forced to the conclusion that this Miocene insect had already reached a position far from the primitive end of the panorpid line of descent. But when we examine the venation, we find a very different set of facts. In the subfamily Panorpinæ, which includes Panorpa, Neopanorpa, Leptopanorpa, and Panorpodes, the radial sector possesses five branches (R2a, R2b, R3, R4, R5), although a four-branched condition, in which R2 is simple, occurs irregularly and sporadically in some specimens. The media is always four-branched (M1, M2, M3, M4). Now in Holcorpa, as we have noted above, Rs possess six branches, R2a being deeply forked; and M has five branches, the extra branch being attached to M4. Nowhere among the recent Panorpidæ do we meet with an approach to this condition, except in the genus Chorista, where the media of the fore wing has five branches. In the hind wing of Chorista, however, the media has only four branches, as in other members of the family, and the radial sector of both wings consists of four branches. Since it has already been established by several investigators that the primitive and basic condition of the venation of the Mecoptera included a six-branched radial sector and at least a five-branched media, Holcorpa is placed by its venation near the very bottom of the panorpid series, although the body structure puts it close to the top.

The interesting affinities of Holcorpa, together with the condition of its venation, lead us to consider the other fossil Mecoptera belonging to recent families. Four species have been referred to the family Panorpidæ, and five to the Bittacidæ; these are included in the following synopsis:

Family Panorpidæ

ELECTROPANORPA, new genus.

Allied to Panorpodes. Beak short and stout; 6th, 7th and 8th abdominal segments not modified; wings with a six-branched Rs, and a five-branched M.
Genotype: *Panorpa brevicauda* Hagen.

Electropanorpa brevicauda (Hagen)

Panorpa brevicauda Hagen, 1856, in Berendt's Berst. befindl. organ. reste. vorw.. 2(1): 91; pl. 8, fig. 21.

Panorpa brevicauda Handlirsch, 1908, Foss. Ins.: 911.

This species was based upon a male specimen from the Baltic amber (Oligocene). Hagen states that the head has the ordinary configuration of a Panorpa, although the beak is stout and shorter. His figure of the abdomen shows that the 6th, 7th, and 8th segments are unmodified, like those of Panorpodes. This feature alone eliminates the species from Panorpa. The wing venation is especially interesting, because we again find the condition which was present in Holcorpa,—a six-branched Rs, and a five-branched M. Consequently although its shortened beak and abdominal structure place *brevicauda* close to Panorpodes, the wing venation requires that it be assigned to a separate genus, and for this reason Electropanorpa is established.

Family Bittacidæ.

ELECTROBITTACUS, new genus.

Allied to Bittacus. Rostrum greatly reduced; venation identical with that of Bittacus.

Genotype: *Bittacus antiquus* Pictet.

Electrobittacus antiquus Pictet

Bittacus antiquus Pictet, 1854, Traité de paleont., 2nd ed., 2: 379; pl. 40, fig. 26.
Hagen, 1856, in Berendt's befindl. organ. reste. vorw., 2(1): 92; pl. 7, fig. 23; pl. 8, fig. 22.
Handlirsch, 1908, Foss, Ins.: 911.

This remarkable insect was originally described from two Baltic amber specimens, and Hagen subsequently obtained two additional specimens, both of which were splendidly preserved. The wing venation is the same as that of Bittacus, but the rostrum is exceedingly short, fully as small as that of Panorpodes. This characteristic at once eliminates *antiquus* from Bittacus and from all the other genera of the Bittacidæ. Only in certain species of Panorpodes (Panorpidæ) is the rostrum similarly abbreviated; and I believe that *antiquus* occupies a position in the family Bittacidæ analogous to that held by Panorpodes in the Panorpidæ.

Palæobittacus Carp.

Allied to Bittacus. Differs from Bittacus in the possession of a five-branched media, and a cross-vein between Rs and M at the base.

Genotype: *Palæobittacus eocenicus* Carp.

Palæobittacus eocenicus Carp.

Palæobittacus eocenicus Carp., 1928, Ann. Carnegie Mus., 18: 240–249; fig. 1; pl. 12.

This species was based upon a splendidly preserved specimen from the Green River Shales of Colorado (Eocene). The body structure is similar to that of Bittacus, but the media has the extra branch on M4 that we have seen in Holcorpa and Electropanorpa.

Probittacus Martynov.

Allied to Bittacus. M with five branches.

Genotype: *Probittacus avitus* Mart.

Probittacus avitus Mart.

Probittacus avitus Mart., 1927, Bull. Acad. Sci., U.S.S.R., 21: 661–665; fig. 11.

This important insect is known to us only by a well preserved fore wing from the Jurassic beds of Galkino, Turkestan, and is the only Mesozoic Mecopteron which can be referred to a recent family. Martynov originally placed it within the extinct family Neorthophlebiidæ, but the wing is identical with that of Bittacus, except for the extra branch on M4. The discovery of such an insect in the Jurassic, so close to an existing type, is very unexpected.

All the other fossil Mecoptera which have been referred to recent families must be eliminated entirely from the order or be temporarily placed in an uncertain position, until additional material has been secured. *Panorpa rigida* Scudder, from the Florissant shales, is too incompletely preserved to permit even family classification. *Panorpa arctiiformis* Ckll., also from the Florissant shales, is undoubtedly a member of the family Panorpidæ, but I have not seen the type specimen and there is nothing in the description to indicate its affinities. *Dinopanorpa*

megarche Ckll., from the Miocene of Siberia, is certainly not a member of the Panorpidæ, and may not even be a scorpion-fly. *Bittacus reticulatus* Heer, from the Miocene of Radoboj, was based upon a minute fragment of a wing which exhibits no mecopterous features whatever; and *Bittacus validus* Hagen, while possibly a Mecopteron, cannot belong to the Bittacidæ, for the venation is utterly different from that characteristic of the family.

From this survey of the fossil Mecoptera which belong to recent families, it is clear that only five species are completely enough known for us to determine their affinities: Probittacus, Electrobittacus, Palæobittacus, Electropanorpa and Holcorpa. But small as this list is, I believe that we can derive sufficient data from these fossils to throw some light on the evolution of the rostrum and the venation in the Bittacidæ, and the Panorpidæ. For in both of the above representatives of the Panorpidæ (Holcorpa and Electropanorpa) the radial sector is six-branched and the media is five-branched, although the body structure is fully as highly specialized as that of the recent Panorpas. So

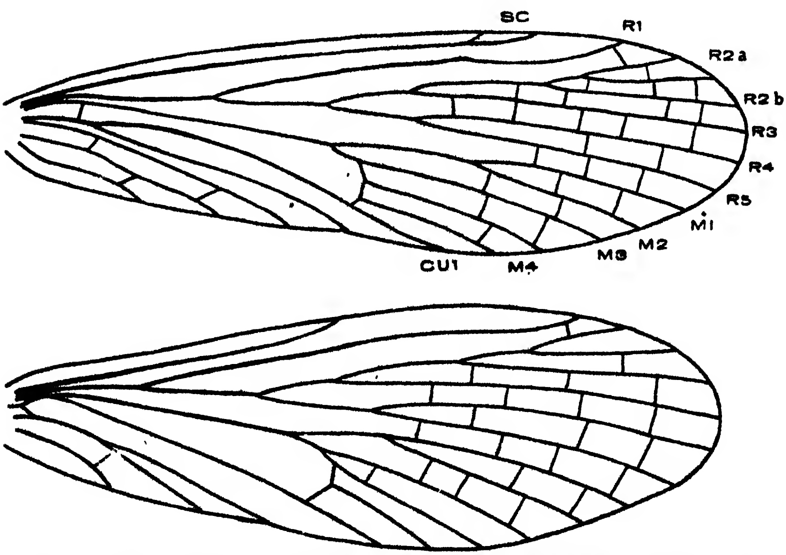


FIG. 2. Fore and hind wings of *Orthophlebia communis* Westw., from the Lower Lias of England; drawn from specimens in the Museum of Comparative Zoology.

far as the venation is concerned these two genera are practically identical with the Mesozoic Orthophlebias (Fig. 2) and are intermediate between them and the true Panorpidæ. This idea of the descent of the panorpids from the Orthophlebiidæ has long been established, but the point which I wish to emphasize here is that these Mesozoic Orthophlebiids *possessed a long beak similar to that of Panorpa.*[1] This is strong evidence that the short rostrum of Panorpodes is not a primitive trait, as usually supposed, but a specialized one, formed by the secondary reduction of the parts concerned. Enderlein came to this same conclusion many years ago from a brief survey of the phylogeny of the Mecoptera.[2] In the fossil Bittacidæ which we have just considered the radial sector has already been reduced to the four-branched condition, as in all living genera, but the media is still five-branched (except in Electrobittacus) the extra branch of M4 being best developed in the Jurassic Probittacus. The wings of these fossil genera are therefore intermediate between those of the true Bittacidæ and some of the Orthophlebiid types, which possessed a perfect rostrum. The condition of the rostrum in Electrobittacus is apparently another result of reduction and specialization, analogous to the situation in Panorpodes. All the fossil evidence available at the present time agrees in showing that the Panorpidæ were derived directly from the Orthophlebiids, gradually losing a branch of the radial sector and of the media, and also attaining in Panorpodes a complete reduction of the rostrum. The Bittacidæ seem to be a side-branch of the Orthophlebiids, having already acquired by the Jurassic a four-branched radial sector, but retaining the five-branched media until recent times, when the four-branched media has also become the normal.

This combination of specialized body structure and relative primitive venation in the fossil Panorpidæ and Bittacidæ points definitely to the conclusion, which has not previously been considered, that the evolution of the venation has lagged behind that of the body structure; and that the present body structure of the two families was already established by the middle Meso-

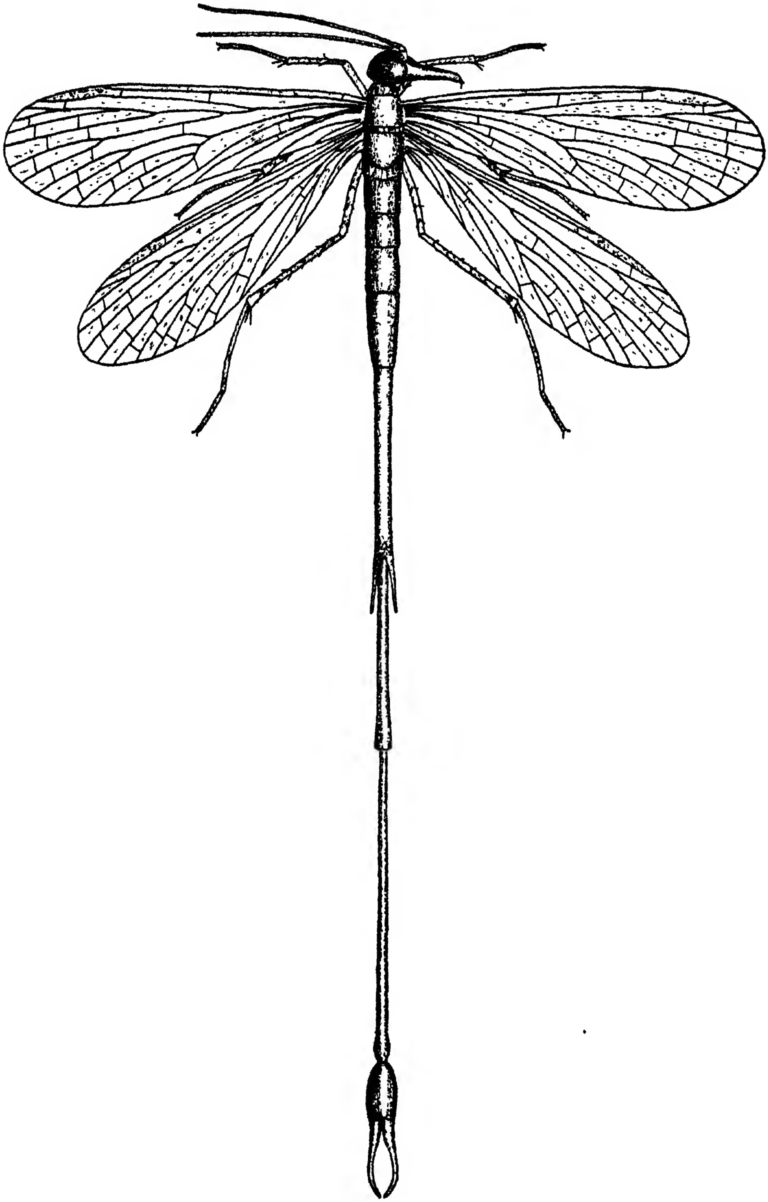
[1] See Martynov's figures, Bull. Acad. Sci. U. S. S. R., 21; 657.

[2] Zool. Anz.; 35 (12/13): 385–399, 1910.

zoic, although the venation was still in the process of modification. The body structure of *Holcorpa maculosa* is essentially so modern, even to the genitalia, that on this basis alone we might be tempted to determine the insect as a living species; but the venation is the same as that possessed by the Mesozoic Orthophlebias. This retarded modification of the venation in the Mecoptera enables us to trace the phylogeny of these insects more accurately by the wing venation than by the body structure.

PLATE XXXIII

Holcorpa maculosa Scudder, allotype. The abdomen has been straightened in order to show its extreme length. All structures figured here are preserved in the fossil.



HOLCORPA MACULOSA

STUDIES IN THE PYRRHOPYGINÆ, WITH DESCRIPTIONS OF SEVERAL NEW SPECIES (LEPIDOPTERA, RHOPALOCERA, HESPERIIDÆ)

BY E. L. BELL

The two genera treated in this first paper comprise a considerable number of large and beautiful *Hesperiidæ*, among which there are groups of species bearing a very close superficial resemblance to each other and having very little in the way of maculation that will serve as constant characters for their separation. Despite the close superficial appearance the details in the form of the male genitalia differ materially and in many cases it is only through an examination of these parts that a satisfactory identification may be made. It is unfortunate that the description of some of the species is so very brief, omitting many important details, and those mentioned applying as well to other species as the one described. This has been the cause of much misidentification and confusion.

The writer, having found it quite impossible to identify accurately the material in his collection, from any of the published papers dealing with these insects, has spent many months in comparing all of this material with the original descriptions, and the figures when given by the authors, and in the study of the male genitalia where specimens were available for dissection. As the result of these studies, it has been found, in some instances, that the insect to which a certain name is usually applied does not agree with the type. This is pointed out and corrected in subsequent pages of this paper. It has also resulted in the discovery of several apparently undescribed species.

It is, of course, quite possible that the writer may make some misidentifications, owing to the difficulty, if not impossibility, of determining from the insufficient descriptions just what was before the authors when they wrote them. In any event the accompanying figures of the male genitalia will provide a certain

means of identification of the species treated in this paper under a given name, and if it is possible at some time to examine the type of the various species that have been described, if it can be found, and the form of the genitalia differs from that figured here, then the proper correction may be made. In the meantime there will be some certainty as to which insect a given name applies. It has been impossible to obtain material in a number of species and therefore no examination of these could be made.

In addition to the omission of many characters in the descriptions, confusion occurs as to the meaning of an author when referring to the anterior part of the insect's thorax, it being evident that the terms "collar" and "shoulder covers" and other terms used by various authors do not always apply to the same thing; therefore in this paper Plate XXXIV, Fig. A, is given in explanation of the parts referred to. The use here of the term "pectus red" refers to what is often stated as "red-spotted anterior coxæ."

While as a whole the superficial characters are reasonably constant, there must be expected a certain amount of individual variation in such things as the extent of the darkening of the fringes in the apical area of the primaries, the width of the basal or marginal spots or bands of either wing, in some species the presence or absence of a spot on each side of the shoulder covers, and in one species at least (*scylla* Menetries) in the color and extent of the coloring of the tegulæ.

A considerable number of slides have been made of the male genitalia, and where the material afforded it several of a species were made, but in some species only a single example was available, so it is uncertain just how much individual variation may occur in these species. The form has been found to be quite constant in those species where a number of individuals were examined, the variations in detail being no more than one would expect to find. The result has been to separate a number of species which differ but little in superficial appearance though having a distinct form of the genitalia and there seems to be no recourse but to describe these as new together with those remaining after all of the present names in use have been applied in accordance with the characters given in the original description.

From the figures given in this paper it will be noted that there is a similarity of form in certain species, the superficial appearance of which seems to preclude the possibility of their being other than closely related. The characters found in the form of the genitalia are here used to divide the genus *Pyrrhopyge* into several well defined groups and this division seems to be borne out in the general external resemblance of the species thus brought together. It may some time be deemed sufficient evidence to warrant the separation of some of these groups into genera of their own, but for the present it seems best to leave the genus as it is and merely group the species according to the genitalic characters. Most of those species which were not available for examination have been left in the first group, that is group A, but they may not all belong there; when material in these species is available for examination they can readily be removed to some other group if necessary. Plate XXXIV, Fig. B, illustrates the parts referred to in the remarks on the genitalia.

The following list of species is based on the paper of Mabille and Boullet and that contained in Seitz, "Macrolepidoptera of the World," with the addition of those since described. The writer has briefly summarized the principal superficial characters of the species before him; where no material was available, the original description is cited. As the published records of distribution are apt to contain errors in determination, the one given in this paper is for the most part only the type locality mentioned in the original description and of the specimens at hand.

The records of distribution are followed by abbreviations in parenthesis, indicating the collection in which the specimens are located or the authority for the record; these are explained as follows: (A.S.) Academy of Natural Sciences, Phila., Pa.; (A.M.) American Museum of Natural History, N. Y. City; (B.M.) British Museum, London, England; (G. & S.) Godman and Salvin, Biol. Centrali-Americana; (B.) the collection of the author.

In the references to Hewitson's "Exotic Butterflies" it has been necessary to omit the data in regard to the text, as the

pages are unnumbered, but the text accompanying the figures cited will be found in close proximity to the plates.

In the descriptions of new species in this paper all measurements of expanse are from the center of the thorax to the apex of the primary × 2.

Grateful acknowledgment is hereby made of the invaluable assistance rendered by my good friends, Capt. R. C. Williams, Jr., Mr. F. E. Watson, Capt. N. D. Riley and Dr. William Schaus, in the loan of specimens and slides of genitalia, help with references to the literature and expert advice, without which it would have been necessary to omit a great deal from this paper. Capt. Riley has been most kind in examining types in the British Museum collection and informing the writer of their exact characters, as well as in making an examination of the genitalia of one of them (*latifasciata* Butler) and in sending an excellent drawing of it in order to confirm the identification of that species. Figure A is also copied from a drawing made by Capt. Riley.

PYRRHOPYGE

Hubner, Verz. bek. Schmett., p. 102, 1816.

Some confusion has obtained in the fixation of the type of this genus, and the writer believes that it is better to follow the action of Scudder, (Historical Sketch. Proc. Amer. Acad. of Arts and Sciences, Boston, second series, vol. 2, pp. 261, 262, 1875); Watson, (Proc. Zool. Soc., London, p. 11, 1893); Godman & Salvin, (Biol. Centr.-Amer., Rhopal., vol. 2, p. 247, 1893, under *phidias* Linnaeus), in considering the type to be *hyperici* Hubner.

GROUP A. *P. hyperici* section (typical)

Genitalia. The species included in this group have the same form in the various parts as in *hyperici* Hubner, the termination of the claspers naturally varying in detail among the species. The apex of the uncus is rather broad, rounded and bifid. From the base of the uncus projects a flange on both sides, which varies in shape from triangular, or irregularly so, to a narrow rod-like projection which may be very long and upcurved towards the termination; these flanges are usually ser-

rate and more or less shagreened. The girdle is long. The saccus is moderately long. The aedoeagus is somewhat bulbous at the base, a little bent, tapering to the apex before which there is usually a small lobe with a few serrations. The aedoeagus is firmly attached to the tip of the saccus by very strong muscles (Fig. 8) and passed through the upper part of a cup-shaped process between the two sides of the girdle (Figs. 23, 25, 30).

1. Fringes white.

a. With a white or bluish-white marginal area of the secondaries, above, below, or both.

P. hyperici (Plate XXXV, Fig. 1).

Hubner, Zutrage Samml. exot. Schmett, pp. 16–17; figs. 271–272; 1823.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 173, 179, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, pl. 162a, 1921.

Wings greenish-black. Secondaries above with an irregular, bluish-white marginal area; beneath with a bluish-white basal area extending to almost the outer margin. Head red in front and just back of the antennæ in the center. Palpi and anal tuft red. Collar, shoulder-covers, tegulæ and pectus blue-black. The fringes of the primaries in the one specimen at hand are nearly all black, showing but a few white scales between veins 1 and 3; of the secondaries white from the anal angle to nearly the outer angle.

Distribution. Type locality: Brazil.
Para, Brazil (B), (A.M.).

P. sergius (Plate XXXV, Fig. 2).

Hopffer, Stett. Ent. Zeit., vol. xxxv, p. 369, 1874.

Godman, Ann. & Mag. Nat. Hist., ser. 7, vol. xx, p. 155, 1907.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 173, 179, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, pl. 162 a, 1921.

The species to which the name *sergius* is applied in this paper, has black wings with a dark bluish sheen. The secondaries be-

neath have a marginal bluish-white band extending from the outer angle to the anal angle, broad at the former and ending in a point at the latter angle, it is crossed by the black veins and somewhat dentate on the inner edge. The inner edge of the band runs in practically a straight line. Head red in front, at the back red in the center bordered with black. Palpi and anal tuft red. Collar red and black mixed. Shoulder-covers, tegulæ, and pectus black. Fringes white darkened at the apex of the primaries.

Erschoff's *leucoloma* has been placed by authors as a synonym of *sergius,* but Godman in the paper above referred to, states that the Plotz figure (drawing no. 1599) of *leucoloma* has the marginal bluish-white band of the underside of the secondaries extending further inward. There are before us individuals which show this difference in the shape of the band and each has a distinct form of the genitalia. The two insects have therefore been separated and identified on the basis of Godman's remarks.

Distribution. Type locality: Chanchamayo, Peru.
Chanchamayo, Peru; La Merced, Chanchamayo, Peru (B).

P. leucoloma (Plate XXXV, Fig. 3).

Erschoff, Russ. Ent. Obshch, Trudy, vol. viii, p. 146, pl. 3, fig. 2, 1874–1876.

Plotz, Stett. Ent. Zeit., vol. xl, p. 532, 1879.

Godman, Ann. & Mag. of Nat. Hist., ser. 7, vol. xx, p. 155, 1907.

The insect identified as *leucoloma* has black wings with a dark bluish sheen as in *sergius.* The secondaries beneath have a bluish-white marginal band extending from the costal vein at the outer angle, where in the last interspace it is composed of scattered scales, to the anal angle, where it is extended to the inner margin in scattered scales; it is crossed by the black veins and is somewhat dentate on the inner edge, which does not run in a straight line as in *sergius* but is noticeably broader in the center than at either end. Head red in front, in back red in the center bordered with black. Palpi and anal tuft red. Collar red in the center, black at the extreme sides. Shoulder covers, tegulæ

and pectus black. Fringes white, darkened at the apex of the primaries. As noted under *sergius* this species is separated by the differently shaped marginal band of the underside of the secondaries as noted by Godman.

Distribution. Type locality: "In the neighborhood of Monterico, Peru."
Peru (B).

P. araethyrea (Plate XXXV, Fig. 4).
Hewitson, Equat. Lep., p. 70, 1870.
Hewitson, Exot. Butt., vol. iv, Pyrrh. pl. iii, fig. 18, 1871.
Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 173, 179, 1908.
Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, pl. 162 a, 1921.

Wings greenish-black. Secondaries above with a white or bluish-white marginal area, somewhat variable in width, extending from, or near, the outer angle to the anal angle and broadly crossed by the black veins, varying in number from five to six according to the extent of the band. Beneath the outer half of the wing is white, crossed by the black veins, less heavily than above, the band extending from the costal margin to the anal angle. Head, palpi, collar, and anal tuft red. Shoulder-covers, tegulæ and pectus black. Fringes white, darkened toward the apex of the primaries.

Distribution. Type locality: Ecuador.
Ecuador (B).

P. aziza (Plate XXXV, Fig. 5).
Hewitson, Trans. Ent. Soc., London, 3rd Series, vol. 2, p. 483, 1866.
Hewitson, Exot. Butt., vol. iv, Pyrrh. pl. iii, fig. 19, 1871.
Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 173, 179, 1908.
Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, 1921.

Wings greenish black. Secondaries with a broad bluish-white marginal band which curves slightly inward toward the outer

angle thus leaving that part of the margin black, it is crossed by the black veins. The secondaries beneath with the basal two-thirds white, crossed by the black veins, the extreme base is narrowly black. Head, palpi, collar, and anal tuft red. Tegulæ greenish black. Pectus black. Fringes white, darkened toward the apex of the primaries. *Aziza* somewhat resemples *arathyrea* on the upper side but differs below in having the white area, basal, instead of marginal as in the latter species.

Distribution. Type locality: "New Granada."
Mesopotamia, Dept. of Antioquia, Colombia (A.M.).

P. garata.

Hewitson, Trans. Ent. Soc., London, 3rd Series, vol. 2, p. 483, 1866.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 173, 179, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, pl. 162 a, 1921.

The description states that the upperside is blue black. The head, palpi and anus scarlet. Posterior wing bordered with white. Underside as above, except that the posterior wing is irrorated with pale bluish between the nervures from the middle to the outer margin. There were no specimens for study.

Distribution. Type locality: Surinam.

b. No white marginal area of secondaries. Tegulæ bordered with red.

P. papius (Plate XXXV, Fig. 6).

Hopffer, Stett. Ent. Zeit., vol. xxxv, p. 369, 1874.

Plotz, Stett. Ent. Zeit., vol. xl, p. 537, 1879.

Wings deep brownish black. Fringes white, darkened toward the apex of the primaries. Head, palpi and collar black. Pectus and anal tuft red. Shoulder covers black with a red spot on each side. Tegulæ red on the upper side and black on the lower side. A tuft of red hairs at the base of the thorax, on each side. Hopffer does not mention the color of the palpi but Plotz states that they are black. Mabille and Boullet appear to have identi-

fied a different insect (Ann. des Sciences Nat., Paris, p. 174, 1908) as *papius* as they say "palpi red, more or less bordered with black" and in this they are followed by Draudt (Seitz, Macrolep. of the World, vol. 5, p. 837, 1921).

The species referred to as *scylla* Menetries in the Mabille and Boullet paper, (p. 173) seems to be *papius*, while the species they refer to as *papius* seems to one that will be dealt with subsequently in this division. The Draudt figure (pl. 162 a) of *scylla* appears to represent *papius* except that the fringes of the primaries are too dark, which may be due to the printing of the figure. This insect is often misidentified as *scylla*, in collections.

Distribution. Type locality: "One specimen from New Granada and one from Moxos (Pavon)."
Colombia, Ecuador, Peru, (A.M.); (B). Brazil (A.M.).

P. decipiens (Plate XXXV, Fig. 7).

Mabille, Genera Insectorum, Hesp., p. 8 (notes), 1903.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 179, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, 1921.

Wings dark brown. Fringes of the primaries white mixed with brown scales, becoming entirely brown toward the apex; of the secondaries white. Head, palpi and collar black. Shoulder-covers black with a red spot on each side. Tegulæ red on the upper half, black on the lower. Anal tuft red. Pectus red, bordered with black on the outer edge and base. There is a small red spot near the base of the secondaries beneath.

Distribution. Type locality: In the original description Mabille gives Bolivia, but in the Mabille and Boullet paper Ecuador is given. Ecuador (B). Peru (A.M.).

P. melanomerus.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 179, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, 1921.

The original description states "Wings black on the two sides. Corselet and epaulettes red. Fringes white except at the apex of the superiors or they are black between 7 and 8. Thighs black. The writer has not seen this species.

Distribution. Type locality: Bolivia.

P. tarapotoensis new species (Plate XXXV, Fig. 8).

Male. Primaries and secondaries above and beneath dark brownish. Fringes white, darkened on the primaries from vein 3 to the apex and on the secondaries at the outer angle. Head black. Palpi red in the center, bordered with black on each side. Collar black with red hairs intermixed. Shoulder-covers black with a red spot on each side. Tegulæ red on the upper half, black on the lower. Pectus black, intermixed with red in the lower three-quarters. Body black above and beneath. Legs black. Antennæ black.

Expanse: 58 mm.

Type material. Holotype male, Tarapoto, Peru, in collection of the author.

This seems to be the species referred to *papius* in the Mabille and Boullet paper as noted in the remarks under that species.

c. Tegulæ black. Pectus red.

P. charybdis (Plate XXXV, Fig. 9).

Hewitson, Gen. Diurn. Lep., vol. 2, pl. 78, fig. 2, 1852.
Hopffer, Stett. Ent. Zeit., vol. xxxv, p. 370, 1874.
Mabille, Ann. Ent. Soc. Belg., vol. xxi, pp. 13, 14, 1878.
Plotz, Stett. Ent. Zeit., vol. xl, p. 534, 1879.
Godman & Salvin, Biol. Cent.-Amer., Rhop., vol. 2, p. 247, 1893.
Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 180, 1908.
Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, pl. 162 b, 1921.

Both Hopffer and Plotz are evidently correct in their determination of *charybdis* (see notes under *zeleucus* Fabricius). Capt. Riley states he has marked as the type of *charybdis* in the collection of the British Museum, the specimen in the Hewitson collection which agrees with the figure in Genera Diurnal Lepidoptera. The type and another specimen in the Hewitson collection have a rather dull greenish black color of the wings; in

the type the red shoulder covers are divided in the middle as shown in Hewitson's figure, in the other specimen they are continuous. Head and collar red. The pectus red. The tegulæ black. There are specimens before the writer which agree with these characteristics.

Distribution. Type locality: Hewitson's type came from Minas Geraes, Brazil. Manaos; Rio Grande do sul; Parana; Rio de Janeiro; Blumenau, all in Brazil (B). Brazil (A.M.).

P. polemon.

Hopffer, Stett. Ent. Zeit., vol. xxxv, p. 371, 1874.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp 174, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, pl. 162 b, 1921.

The original description states that the wings are blue-black; fringes white; head, palpi and a stripe on the anterior coxæ saffron; prothorax and shoulders black; anal abdominal segement black, saffron bearded. Mabille & Boullet place *polemon* in the division having "anterior thighs black," whereas Hopffer's description states "orbita coxisque anticis croceis" and is placed in his own division, with those species "mit rothen Vorderhuften." It seems conclusive that the insect that was before Hopffer had a red pectus ("rothen Vorderhuften") and that Mabille and Boullet have identified some other species as *polemon*, incorrectly. There are no specimens before the writer that he can identify as *polemon*.

Distribution. Type locality: Brazil.

d. Pectus black. Shoulder-covers black or only spotted with red.

P. zeleucus.

Fabricius, Ent. Syst., vol. 3, part I, pp. 346, 347, 1793.

Hopffer, Stett. Ent. Zeit., vol. xxxv, p. 370, 1874.

Mabille, Ann. Ent. Society Belg., vol. xxi, p. 13, 1878.

Plotz, Stett. Ent. Zeit., vol. xl, p. 534, 1879.

Godman & Salvin, Biol. Cent.-Amer., Rhop., vol. 2, p. 247, 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, pl. 162 b, 1921.

The Fabrician description is in itself insufficient for accurate determination of specimens. Both Hopffer and Plotz state that *zeleucus* has black anterior coxæ (pectus) and are probably correct, however, Mabille applies the name to a species having red anterior coxæ and in this are followed by Godman & Salvin and Mabille & Boullet, and also by Draudt. Godman & Salvin state that both Hopffer and Plotz have erred and have transposed the names *zeleucus* and *charybdis*, the evidence, however, does not bear out this statement, for, as noted under *charybdis*, the Hewitson type of that species has a red pectus. Capt. Riley has informed the writer that the specimen in the British Museum series of *charybdis* which Godman & Salvin apparently took to be the type of the species and which is marked "type?", has been in the collection for over one hundred years and is no. 305 in the old Museum Catalogue as "*Thamyris zeleucus*" from Brazil. It is blue-black in color and has a black pectus; the fringes white, darkened from between veins 3–4 to the apex of the primaries; the hind wing margin is more excavate than in the actual type of *charybdis*; the shoulder-covers entirely black; tegulæ black; head, collar and anal tuft red. The writer has no specimens before him which agree with this.

Distribution. Type locality: "Habitat in Indiis."

P. zenodorus (Plate XXXV, Fig. 10).

Godman & Salvin, Biol. Cent.-Amer., Rhop., vol. 2, p. 247; vol. 3, pl. 73, figs. 1, 2, 3, 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, 1921.

Wings blue-black. Fringes white, darkened toward the apex of the primaries. Head, palpi and anal tuft orange-red. Collar red. Shoulder-covers, tegulæ and pectus blue-black.

Distribution. Type locality: Actual type locality not given but the following countries are mentioned: Mexico, Guatemala, Costa Rica, E. Peru. Jalapa, Mexico (B). Cordoba, Mexico; Guatemala; British Honduras (A.M.).

P. proculus.

Hopffer, Stett. Ent. Zeit., vol. xxxv, p. 370, 1874.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 b, 1921.

The original description states that the wings are blue-black. Fringes white. Head and palpi purple-red, except the occiput, throat and "genis" which are black. Anal extremity purple-red. Prothorax and anterior coxæ (pectus) blue-black. There are no specimens at hand which agree with this description.

Distribution. Type locality: Guiana.

P. attis new species (Plate XXXV, Fig. 11).

Male. Upperside. Primaries and secondaries blue-black. Fringes entirely white or darkened toward the apex of the primaries. Beneath the wings are the same color, tinted somewhat violaceous on the inner margin of the primaries. Head, palpi and anal tuft, carmine. Collar, carmine. Shoulder-covers entirely blue-black or with a rather small, roundish carmine spot on each side. Tegulæ blue-black, sometimes with a few scattered carmine hairs at the base. Body blue-black above and beneath. Female similar.

Expanse: Male, 48 to 56 mm. Female, 60 mm.

Type material. Holotype male and allotype female, Santa Cruz, Bolivia, in the collection of the author. Paratypes, 5 males and 1 female, Santa Cruz, Bolivia, in collection of the author; 1 male, 75 kilometers northwest of Santa Cruz, Bolivia, in collection of Academy of Natural Sciences, Philadelphia, Pa.; 1 male, Viota, Colombia, in collection of the American Museum of Natural History, New York City. The form of the genitalia is similar to that of *phidias* Linnæus but the lack of the white area at the base of the secondaries beneath readily separates the two species and the secondaries of *attis* are not quite so concave

on the outer margin as in *phidias*. The three following species are very similar to *attis* in their superficial appearance and they can be separated satisfactorily only by the form of the male genitalia.

P. rileyi new species (Plate XXXV, Fig. 12).

Male. Upperside blue-black. Beneath the same, tinted violaceous on the inner margin and base of the primaries. Head, palpi and anal tuft, carmine. Collar, carmine. Shoulder-covers and pectus, blue-black. Tegulæ, blue-black. Fringes white, darkened at the apex of the primaries.

Expanse: 52–54 mm.

Type material. Holotype male and 3 male paratypes, Santa Cruz, Bolivia, in collection of the author.

This species is usually somewhat smaller than *attis*, but as small specimens of *attis* occur, they cannot be accurately separated on size. The form of the male genitalia is different in the two species, as the figures show.

This species is named for my friend, Capt. N. D. Riley.

P. amythaon new species (Plate XXXV, Fig. 13).

Male. Upperside. Primaries and secondaries, greenish-black. Beneath the same, tinted violaceous-brown at the base of the primaries. Fringes white, darkened toward the apex of the primaries. Head, collar and anal tuft, red. Shoulder-covers, pectus and tegulæ, blue-black.

Expanse: 56 mm.

Type material. Holotype male, Pernambuco, Brazil, in collection of the American Museum of Natural History, New York City.

This species, in the one specimen at hand, has a more greenish sheen than the two previous species and the form of the genitalia is quite distinct.

P. williamsi new species (Plate XXXV, Fig. 14).

Male. Upperside. Primaries and secondaries dark greenish or bluish black. Beneath the same, tinted violaceous on the inner margin, and brownish at the base, and along the costal margin of the primaries for about one-half the length. Fringes white, darkened at the apex of the primaries and a little at the outer angle of the secondaries. Head red in front and half way back behind the antennæ, the rest black; the red part at the back of the head is confined to the central part. Anal tuft, red. Collar, red in the center, the rest black. Shoulder-covers and tegulæ, black. Pectus

black. The females associated with this species are similar, except that the red part of the head behind the antennæ is broader, so that the black border at the sides is absent.

Expanse: Male, 50–56 mm. Female, 56–58 mm.

Type material. Holotype male, Peru, in collection of the author. Allotype female, Caracas, Venezuela, in collection of the American Museum of Natural History, New York City. Paratypes: 1 male, St. Ann's, Trinidad, in collection of the author; 1 male, Colombia or French Guiana, in collection of the Academy of Natural Sciences, Philadelphia, Pa.; 1 male, Colombia, 1 male, Caracas, Venezuela, 1 female, Caracas, Venezuela, in collection of American Museum of Natural History, New York City.

This species is named for my friend, Capt. R. C. Williams, Jr.

This species is apparently close to *proculus* Hopffer, but the description of that species states that the entire back of the head is black.

e. Pectus black. Shoulder-covers red.

P. lamprus.

Hopffer, Stett. Ent. Zeit., vol. xxxv, p. 370, 1874.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, p. 174, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, pl. 162 b, 1921.

The description states that the wings are blue-black on both sides. Fringes white. Head, palpi, "genis," prothorax, shoulders, last two abdominal segments of the male, of the female the anal segment only, are blood-red. Anterior coxae black. Hopffer compares *lamprus* with *charybdis* Hewitson from which he distinguishes it by *lamprus* having black anterior coxæ instead of red as in *charybdis*, an additional red abdominal segment and red shoulders. Mabille & Boullet misspell the name "*lampros*" and place it in the division having "prothorax black" despite the fact that Hopffer distinctly says "prothorace sanguineis." The misspelling of the name has been continued by other authors.

Distribution. Type locality: Brazil.

The writer cannot identify any of the specimens before him, as *lamprus.*

f. Third and fourth abdominal segments edged with red, fifth and sixth, red.

P. roscius.

Hopffer, Stett. Ent. Zeit., vol. xxxv, p. 370, 1874.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, 1921.

The description states that the wings are blue-black. Fringes white. Head black, varied with red hairs. Palpi, prothorax, shoulders and fifth and sixth abdominal segments blood-red, third and fourth abdominal segments posteriorly bordered with blood-red. Anterior coxæ, black.

Distribution. Type locality: Brazil.

The writer has not seen this species.

g. Pectus white striped with carmine tufts. Palpi white.

P. rhacia.

Hewitson, Exot. Butt., vol. v, Pyrrh. pl. v, fig. 37, 1874–1875.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 b, 1921.

The description states that the wings are blue-black, the posteriors tinted with green beneath. Fringes white. Front of the thorax broadly carmine. Palpi white. Breast marked with two longitudinal bands of white with tufts of carmine hair.

Ditribution. Type locality: Minas Geraes.

The writer has not seen this species.

h. With a white area at the base of the secondaries, or primaries or both.

P. phidias (Plate XXXVI, Fig. 15).

Linnæus, Syst. Nat., 10th Ed., vol. 1, p. 485, 1758.

Linnæus, Mus. Ulr., p. 334, 1764.

Linnæus, Syst. Nat., 13th Ed., vol. 1, part 2, p. 795, 1767.

Godman & Salvin, Biol. Cent.-Amer., vol. 2, pp. 246, 247; vol. 3, pl. 73, fig. 4, 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 c, d, 1921.

mænas Fabricius, Mant. Ins., vol 11, p. 90, 1787; Ent. Syst., vol. 111, part 1, p. 347, 1793.

We follow Godman & Salvin in applying the name *phidias* to the insect in which the form of the male genitalia agrees with the "Biologia" figure. We also follow authors in placing *mænas* Fabricius as a synonym of *phidias*, the descriptions of these two being entirely insufficient for accurate determination. Draudt places *mænas* as a synonym of *bixæ* Cramer but that insect in the typical form has a white band extending across the base of the primaries also, whereas the Fabrician description mentions only a white band on the secondaries. *Phidias* is a robust insect, the wings greenish or bluish-black with a brilliant sheen. Head, collar and anal tuft, red. Pectus, shoulder-covers and tegulæ, blue-black. Fringes white, darkened at the apex of the primaries. The white basal band of the underside of the secondaries is usually narrow, irregular on the outer edge, and spotty in appearance, however, it varies in appearance among individuals. In occasional specimens there is a small accumulation of white scales in the basal area of the primaries and sometimes a few red hairs are intermixed at the base of the pectus, barely noticeable except under a lens. There does not seem to be any difference in the form of the genitalia associated with these slight differences in maculation.

Distribution. Type locality: Syst. Nat., 1758, gives "Asia"; Mus. Lud. Ulr., "Luzonis." Of *mænas* "Habitat in America."

Chiva Chiva Trail, Pedro Miguel, Canal Zone, Panama; Muzo, Colombia; French Guiana;

Santa Cruz, Bolivia; Brazil (B).
Peru (A.M.).

P. pseudophidias new species (Plate XXXVI, Fig. 16a, typical; Fig. 16b, variation).

Of the same color and general appearance as *phidias* Linnaeus, but averaging slightly smaller in size. The white basal band of the underside of the secondaries is also similar and there does not seem to be any good superficial character that will separate the two species. The form of the male genitalia is quite different as the figures show. Figure 16b shows a variation in the genitalia, in the extent of the production of the flanges at the base of the uncus, these being much shorter than in the typical form.

Expanse: Male, 48–58 mm. Female, 58 mm.

Type material. Holotype male, Muzo, Colombia; allotype female, Colombia, in collection of the author. Paratypes, 2 males, Muzo, Colombia, 3 males and 1 female, Colombia, 1 male, east Colombia, 1 male, Gatun, Canal Zone, Panama, 1 male, Chiva Chiva Trail, Pedro Miguel, Canal Zone, Panama, 1 male, Ecuador, 1 male, St. Laurent, French Guiana, 1 male and 1 female, Zanderij Island, Surinam, in collection of the author. 3 males, Colombia or French Guiana, 1 male, French Guiana, 1 female, Muzo, Colombia, in collection of the Academy of Natural Sciences, Philadelphia, Pa. 1 male, Cruces Trail, near Corozal, Canal Zone, Panama, 1 male, locality unknown, in collection of American Museum of Natural History, New York City.

The form of the genitalia of *pseudophidias* is quite similar to that of *rileyi* and it may be possible that they are forms of one species.

P. latifasciata (Plate XXXVI, Fig. 17).
Butler, Cist. Ent., vol. 1, p. 176, 1873.
Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175, 180, 1908.
Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 d, 1921.

This species resembles *phidias* Linnæus on the upper side but the white basal band of the underside of the secondaries is usually broader and somewhat angulated externally in the center, the width, however, varies among individuals, which show no

difference in the form of the genitalia. The wings are a shining greenish or bluish-black. Head red, entirely or partly black back of the antennæ, and a black spot in front of the antennæ. Palpi and anal tuft red. Collar usually black, sometimes with a few red hairs intermixed. Pectus, shoulder-covers and tegulæ black. Fringes white, darkened toward the apex of the primaries.

Distribution. Type locality: Bogota.
East Colombia; St. Laurent, French Guiana; French Guiana; Iquitos, Peru (B).
Bogota, Colombia (A.M.).

Capt. Riley has very kindly made an examination of the genitalia of Butler's type and sent an excellent drawing of it to the writer, with which Fig. 17 agrees in all essential details. The form is very similar to that of *williamsi* (Fig. 14) but that species has no white at the base of the secondaries beneath.

P. infantilis (Plate XXXVI, Fig. 18).

Druce, Trans. Ent. Soc. London, part 2, p. 377, pl. xxi, fig. 1, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 c, 1921.

The wings are dark bluish usually, but in one specimen with a slight greenish sheen. Head red in front and just behind the antennæ in the center, the rest black. Palpi and anal tuft red. Collar, pectus, shoulder-covers and tegulæ, black. Fringes white, darkened toward the apex of the primaries. The white basal band of the underside of the secondaries is broad and occupies the basal half of the wing. In one specimen there is a small accumulation of white scales at the base of the primaries. Of the three males and one female before the writer one came from Peru the others from Brazilian localities, all of the males agreeing in the form of the genitalia, that of one of the Brazilian males being here figured.

Distribution. Type locality: Peru.
Manicore, Rio Madeira, Brazil (As.). Peru; Rio Caiary-Uaupes, State of Amazonas, Brazil (A.M.). Manicore (B).

P. andronicus new species (Plate XXXVI, Fig. 19).

Male. Upperside. Primaries and secondaries blue-black, with a slight greenish reflection in certain lights. Beneath the same with a violaceous tint on the inner margin of the primaries. Secondaries with a white basal band, narrow as in *phidias* Linnæus and angulated outwardly in the center. Body blue-black. Head red in front and just behind the antennæ, the rest black. Palpi, and anal tuft red. Collar, pectus, shoulder-covers and tegulæ black. Fringes white, darkened toward the apex of the primaries.

Expanse: 52–56 mm.

Type material. Holotype male, Macas, Ecuador, in collection of the author. Paratypes, 3 males, Macas, Ecuador; 4 males, Ecuador; 1 male, Colombia, in collection of the author; 1 male, Ecuador, in collection of the Academy of Natural Sciences, Philadelphia, Pa.

This insect has a much narrower white basal band on the underside of the secondaries than *infantilis* Druce, and it is also narrower than in *latifasciata* Butler. The Colombian paratype agrees in the form of the genitalia with those from Ecuador, but the white basal band is somewhat broader and noticeably angulated in the center.

P. draudti new species (Plate XXXVI, Fig. 20).

Male. Upperside. Both wings blue or greenish-black. Beneath the same, somewhat tinted violaceous on the inner margin and base of primaries, which also have two short white rays, one above and one below the costal vein, arising from near but not quite reaching the base, the one below the vein extending further outward than the upper one; a small accumulation of white or pale brownish scales just below the base of the cell, and sometimes in the base of the cell; in the two paratypes from Venezuela there is a small white patch below vein I in the basal third of the inner margin.

Secondaries with a rather narrow, white basal band, curved below the cell toward the inner margin. Fringes white, darkened at the apex of the primaries. Body black. Head red, with a moderate sized black spot before the antennæ. Palpi and anal tuft red. Collar black with a few red hairs in the center, absent in one paratype. Pectus, shoulder-covers and tegulæ black.

Expanse: 50–56 mm.

Type material. Holotype male, Santa Cruz, Bolivia, in collection of the author. Paratypes, 4 males, Santa Cruz, Bolivia; 1 male, St. Laurent, French Guiana, in collection of the author.

2 males, Porto Cabello, Venezuela; 1 male, Rio Songo, Bolivia, in collection of the Academy of Natural Sciences, Philadelphia, Pa.

This species in general appearance is somewhat like *phidias* Linnæus. It seems to be the insect that Mabille and Boullet (Ann. des Sciences Nat., Paris, p. 175, 1908) and Draudt (Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 c, 1921) refer to as *fluminis* Butler, the type of which has a very broad white basal band of both primaries and secondaries; and in which species the form of the genitalia is similar to that of *scylla* Menetries placed in group B of this paper. The specimens before the writer very well agree with the Draudt figure above referred to. Capt. Riley has informed the writer that there are specimens in the British Museum collection, agreeing with the Draudt figure, from Caracas, Venezuela; Villa Nova, Amazons; Pebas, East Peru; Rio Colorado, Peru.

2. Fringes yellow or yellowish. Wings with a green or blue sheen. (In *pelota* Plotz the fringes shade to orange-yellow. In *denticulata* Herrich-Schaffer fringes of secondaries white.)

P. pelota (Plate XXXVI, Fig. 21).

Plotz, Stett. Ent. Zeit., vol. xl, p. 535, 1879.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 178, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, pl. 166 a, 1921.

Wings greenish black. Fringes and a narrow marginal band pale- to orange-yellow; in specimens from Paraguay the color is pale yellow and the band narrow, in those from Bolivia the color is more orange-yellow and the band a little broader. Head, palpi, pectus, collar, shoulder-covers and anal extremity, red. Tegulæ black. The form of the claspers deviates somewhat from the other members of this group.

Distribution. Type locality: Brazil.
Santa Cruz, Bolivia; Villarica, Paraguay (B).
Villarica, Paraguay (A.S.).

P. denticulata.

Herrich-Schaffer, Corresp.-blatt, Regensburg, vol. xxiii, p. 165, 1869; (Prodr. Syst. Lep., part 3, p. 57, 1869).

Plotz, Stett. Ent. Zeit., vol. xl, p. 535, 1879.

Godman, Ann. & Mag. Nat. Hist., ser. 7, vol. xx, p. 150, 1907.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, 1921.

The description states that the fringes of the primaries are yellow and of the secondaries white. Godman states that the species is a *Mysoria* near *pelota* Plotz and that the Plotz figure is from a Rio Negro specimen.

The writer does not know the species.

P. josepha.

Plotz, Stett. Ent. Zeit., vol. xl, p. 534, 1879.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, 1921.

The Plotz description states that the wings are dark green or blue, border of the hind wings somewhat excavated between the veins. Fringes yellow. Palpi and anal extremity red. The writer does not know this species.

Distribution. Type locality: Brazil.

P. josephina.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, pl. 162 g, 1921.

The description states that the fringes are white with a yellowish tint. A fine antemarginal line, orange-yellow, on the forewings as fine as a hair. Head, palpi and abdominal extremity red, femora black. The writer has not seen this species.

Distribution. Type locality: Songo, Bolivia.

P. mina new species (Plate XXXVI, Fig. 22).

Male. Upperside. Both wings greenish-black. Fringes of primaries pale yellow, darkened from vein 4 to the apex; of the secondaries pale yel-

low with an orange spot at the end of each vein, not crossing the entire width of the fringe. Beneath same as above, except that the primaries are tinted a little violaceous on the inner margin and at the base. Head, palpi, collar and anal tuft, red. Pectus, shoulder-covers and tegulæ, black.

Expanse: 54 mm.

Type material. Holotype male, Bolivia, in collection of the author.

This species is named for Mrs. Mina A. Bell.

This species differs from the description of *josephina* Draudt in that the fringes are obviously yellow and have the orange spot at the vein ends of the secondaries and in the lack of any trace of an antemarginal line on either primaries or secondaries.

P. viriditas.

Skinner, Ent. News, vol. xxxi, p. 132, 1920.

The description states "Head, collar and palpi red. Thorax blue above, black below. Abdomen and legs black. Anal tuft orange. Wings dark green above and below. Fringes yellow; very narrow on the primaries and a little more than 1.5 mm. wide on the secondaries.

"Expanse (one wing) 27 mm."

Distribution. Type locality: San Pedro Sula, Honduras.

3. Fringes yellow, orange-yellow or red. Wings brown, olive brown or brownish black.

a. Secondaries beneath red-spotted at the base. Pectus black.

P. martena (Plate XXXVI, Fig. 23).

Hewitson, Exot. Butt., vol. iv; Pyrrh. pl. I, fig. 4, 1869.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 177, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, pl. 166 b, 1921.

The wings are blackish brown, through which the veins show a little darker on the upper side. The primaries have a few red scales along the outer border inside of the fringes. The secondaries have a red marginal band varying in width, usually very broad and cut into by the black veins, making a somewhat dentate inner edge, but when the band is narrower it has a more

even inner edge. On the underside, the red scales on the outer border of the primaries extend further inward in the interspaces between veins 1 and 5. The red marginal band of the secondaries is very broad and crossed by the black veins. The red basal spot extends from the upper part of the cell base to almost the costal margin and in the typical form it is extended outward to the anal angle as a broad red stripe, where it merges with the outer marginal band, in the space above the costal vein; this extension varies with individuals and is sometimes reduced to a few scattered scales barely noticeable except under a lens. The fringes of both wings are red, black at the anal angle of the primaries, often black at the tip of the fringe, and variably intermixed with black toward the apex of the primaries. Head, palpi, collar and pectus, black. Shoulder-covers black with a red spot on each side. Tegulæ red on the upper half, black on the lower. Anal tuft red. A tuft of long, black and red hairs extending from the base of the thorax along each side of the abdomen.

Distribution. Type locality: Ecuador. Ecuador (B).

P. croceimargo (Plate XXXVI, Figs. 24, 25).

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 177, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, pl. 162 f, 1921.

Wings above olive-brown with considerable sheen, the veins outlined in black. Beneath somewhat paler and with a sheen, the black veins showing through. The secondaries with a rather irregular, red basal area or spot which extends across the cell to the costal margin. Fringes orange-yellow. Head, palpi, collar and pectus are black. Shoulder-covers black with a red spot on each side. Tegulæ rather narrowly bordered on the upper side with red, the rest black. Anal tuft red. There are also three specimens from Ecuador which closely agree with those from Bolivia and Peru in the form of the genitalia but differ superficially in that the ground color of the wings is considerably darker on both sides and the sheen therefore less noticeable, the red basal area of the under side of the secondaries is in the form

of two distinct, roundish spots, the red spot on each side of the collar is either absent or confined to a very few red hairs, not noticeable except under a lens and the fringes are more orange-red. Figure 24 is from a specimen from Peru, figure 25 is from one from Ecuador.

Distribution. Type locality: Bolivia. Songo. Bolivia; Peru; Ecuador (B). Peru (A.M.).

P. telassa.

Hewitson, Trans. Ent. Soc., London, 3rd series, vol. 2, p. 484, 1866.

Hewitson, Exot. Butt., vol. iv, Pyrrh. pl. I, figs. 2, 3, 1869.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 178, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, pl. 162 g, 1921.

The description states "Upperside, female, rufous-brown; the outer margins orange, narrow, a longitudinal band on each side of the thorax, and the anus scarlet. Underside as above, except there are two scarlet spots at the base of the posterior wings."

Distribution. Type locality: Ecuador.

P. telassina.

Staudinger, Exot. Schmett., part I, p. 295, pl. 99, 1888.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, p. 178 (as form of *cleopas*), p. 182 (as form of *telassa*), 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, 1921.

Rober, Ent. Mitteil., vol. xiv, p. 100, 1925.

Staudinger distinguished *telassina* from *telassa* Hewitson by the marginal band of the hindwings being only one-third to one-half as broad in *telassina,* and orange instead of scarlet, also by the complete red-brown basal band of the secondaries beneath, which in *telassa* is represented by two scarlet spots, according to the Hewitson description. Rober considers *telassina* to be a distinct species and says that it also differs from *telassa* in the

lighter color of the upper side, which has an olive-green sheen; with only a little brownish hair at the base of the thorax instead of a red hair-tuft; shorter and yellow (not red) fringes of the forewings; shorter red anal tuft; in the little contrast between the color of the primaries and secondaries beneath and in the different shape of the basal red spots on the underside of the secondaries. No mention is made in the original description or in Rober's paper as to the color of the pectus; Mabille and Boullet place *telassina* in the division having a black pectus and we are assuming that they are correct, there being no specimens available.

Distribution. Type locality: Chanchamayo, Peru.

P. tenuis.

Staudinger, Exot. Schmett., part I, p. 295, 1888.

Staudinger described *tenuis* as a form of *telassina,* from which he distinguished it by the very narrow orange marginal band of the hind wings and the brownish red basal spots beneath being formed as in *telassa,* that is, two spots instead of a short, complete band. Mabille and Boullet (Ann. des Sciences Nat., Paris, p. 179, 1908) place *tenuis* in the division having no red basal spots on the underside of the secondaries, it therefore seems that the insect they refer to must be some other than *tenuis* Staudinger. Draudt (Seitz, Macrolep. of the World, vol. 5, p. 840, 1921) credits the authorship to Mabille & Boullet. There is nothing before the writer that can be identified as *tenuis.*

Distribution. Type locality: Chanchamayo, Peru.

P. mendax.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 178, 183, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, 1921.

The description states that the ground color of the wings is black. Secondaries beneath red-spotted at the base. Fringes orange, narrow and blackened on the primaries from vein 5. Shoulder-covers with the extremity red haired. Anterior thighs not red spotted. The writer has not seen this species.

Distribution. Type locality: Peru.

P. punctata.

Rober, Ent. Mitteil., vol. xiv, p. 156, 1925.

Rober allies *punctata* with *phylleia* Hewitson, from which he distinguishes it principally by the more blackish ground color of both sides of the wings; the lighter colored fringes and marginal band; different red hairing of the collar; broader marginal band of the secondaries which is divided by the brown veins; a small red spot at the end of the cell on the underside of the secondaries and palpi and head a darker red. On account of the red spot on the underside of the secondaries, we include *punctata* here in the division having that characteristic. The description does not state the color of the pectus, so we assume that it is black as in *phylleia*. There are no specimens of this species at hand.

Distribution. Type locality: Rio Songo, Bolivia.

P. cleopas.

Mabille, Genera Ins., Hesp., p. 9, 1903. (Manuscript?).

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 178, 183, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, 1921.

The writer has been unable to locate a description of *cleopas* other than that contained in the Mabille & Boullet key, although Mabille lists the species in "Genera Insectorum." In the Mabille and Boullet paper *cleopas* is placed in the group having red spots in the basal area of the secondaries beneath, anterior thighs without red spots and with the following characters: fringes broad, orange almost as far as the apex of the primaries, without the band of the secondaries.

Nervures prominently black on both sides of the wings. Epaulettes bordered with red interiorly. Anus red. There is nothing before the writer that he can identify as this species.

Distribution. Mabille & Boullet give Bolivia and Peru.

b. Secondaries beneath red-spotted at the base. Pectus red-striped.

P. schausi new species (Plate XXXVI, Fig. 26).

Upperside. Both wings deep brownish black, veins very little darker. Beneath the same, inner marginal half of the primaries paler. Fringes and

a narrow, somewhat irregular, marginal band of the primaries are red. The fringes and a much broader marginal band of the secondaries are also red, the band is dentate on the inner edge. Beneath on both wings the marginal band is the same as above, except that on the secondaries it extends a little further inward on both sides of the costal vein. A red basal band of the secondaries, similar to that of *martena* Hewitson, extends from near the base of the cell to the costal margin, and in some individuals is narrowly extended to the marginal band, in scattered scales, above the costal vein. Head, palpi, and collar are black. Pectus black externally, red internally. Shoulder-covers black with a red spot on each side. Tegulæ red on the upper half, black on the lower half. Anal tuft red. Body black. A tuft of red hairs at the base of the thorax on each side.

Expanse: 58–62 mm. (one small individual, 52 mm.).

Type material. Holotype male, Ecuador, in collection of the author. Paratypes, 9 males, Ecuador, in collection of the author; 3 males, Ecuador, in collection of American Museum of Natural History, New York City.

Named for my friend, Dr. William Schaus.

This species resembles *martena* Hewitson, but the pectus is red-striped and not black as in *martena;* the fringes are entirely red to the apex of the primaries, whereas in all of the specimens of *martena* at hand they are more or less sprinkled with blackish. The genitalia differ in form from *martena* in the more slender termination of the claspers, and in the shape of the flanges at the base of the uncus. These differences were shown in all of the specimens of each species examined.

P. pheax (Plate XXXVI, Fig. 27).

Hopffer, Stett. Ent. Zeit., vol. xxxv, p. 368, 1874.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 177, 183, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, pl. 162 g, 1921.

Hopffer's description states that the wings are olive-brown, with darker veins. Body black. Shoulder-covers (tegulæ) and anterior coxæ (pectus) black inwardly red haired. Anus saffron. Fringes saffron. Posterior wings with three saffron basal spots. No marginal band of the posteriors. The single specimen identified as this species agrees very well with the descrip-

tion and is from an unknown locality. The form of the male genitalia is very close to that of *croceimargo*.

Distribution. Type locality: Chanchamayo, Peru.

P. olivacea (Plate XXXVII, Fig. 28).
Rober, Ent. Mitteil., vol. xiv, p. 86, 1925.

The description states that this species is like *croceimargo,* both sides of the wings darker, the upper side with a dark olive sheen, under side of the hindwings almost black, without a greenish sheen. Fringes yellow, darker than in *croceimargo*. Veins not standing out in darker color. Breast red. Shoulder-covers more extensively red than in *croceimargo*. Palpi and head black. Collar black with a red spot on each side. Anal tuft yellow red. The parts referred to above as "breast," "shoulder-covers" and "collar" are taken to those shown in Fig. A as "pectus," "tegulæ" and "shoulder-covers."

There are two specimens from Peru before the writer which may be *olivacea* as they agree fairly well with the description except that they have a narrow marginal band of orange-yellow on the secondaries beneath, which is not mentioned in the description. There is also another specimen from Bolivia which is lighter in color above and beneath, with some olive sheen on the under side of the wings also, the marginal band of the under side of the secondaries reduced still further, to a mere line, and which does not materially differ in the form of the genitalia from the Peruvian specimens.

Distribution. Type locality: Peru.

c. Secondaries beneath without red spots. Tegulæ red striped. Head black. Pectus red.

P. rubricolor (Plate XXXVII, Fig. 29).
Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 178, 182, 1908.
Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, 1921.

Wings blackish brown on both sides, somewhat paler on the inner margin of the primaries beneath. Fringes red, black at the apex of the primaries; on the underside of the secondaries

the red encroaches a little on the margin of the wings. Head, palpi and collar are black. Pectus black at the base, the rest red. Shoulder-covers black with a red spot on each side. Tegulæ, upper half red, lower half black. Anal tuft red.

Distribution. Type locality: The description states "Bolivia. Coll. Mus. Paris (Coll. Boullet), 1 male, Equateur.-Coll. Mab. 2 males, Equateur."
Yungilla, Ecuador (B). French Guiana (A.S.).

d. Tegulæ red-striped. Head black. Pectus black.

P. hadassa (Plate XXXVII, Fig. 30).

Hewitson, Trans. Ent. Soc., London, 3rd series, vol. 2, p. 484, 1866.

Hewitson, Exot. Butt., vol. iv; Pyrrh. pl. I, fig. 1, 1869.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 179, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, pl. 162 f, 1921.

The description states "Upperside, female, rufous-brown; the outer margins of both wings orange; a longitudinal band on each side of the thorax, and the anus scarlet."

The figure in Exot. Butt. shows a rather narrow marginal band of the wings, which follows the contour of the margin. Mabille & Boullet say that the band is much broader than the fringe, but the Hewitson figure does not show this. The Draudt figure does not exactly agree with the Hewitson figure in the width of the band. This character may be variable, of course. The two specimens at hand are from Bolivia and they have a marginal band of the secondaries broader than the fringes, thereby agreeing with the key of Mabille & Boullet and the Draudt figure. The genitalia of one of the Bolivian specimens is figured and is somewhat similar in form to *rubricor.*

Distribution. Type locality: Ecuador.
Rio Songo, Bolivia (B).

P. pseudohadassa.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 179, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, 1921.

Wings blackish brown on both sides. Fringes orange, of primaries darkened at the apex; on the secondaries preceded by a very narrow, orange, marginal band on the upper side, which is wider beneath and a little dentate. Head, palpi, collar and pectus are black. Shoulder-covers black with a red spot on each side. Tegulæ, upper half red, lower half black. Anal tuft red. In one individual at hand, from Peru, the color of the fringes is paler orange and there is no marginal band on the upper side of the secondaries, beneath the marginal band is very narrow. There is no material difference in the form of the genitalia in these specimens, which also agrees with Fig. 30 as *hadassa* Hewitson.

Distribution. Type locality: Bolivia.
Amazons, Bolivia, Peru (Mab. & Boull.).
Huancabamba, Peru (B).

P. creona.

Druce, Cist. Ent., vol. I, p. 290, 1874.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 179, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, pl. 162 a, 1921.

aurora Mabille, Ann. Soc. Ent. Belg., vol. xxxv, (C. R. series iv, p. cix) 1891.

The description states that the upper side of the male is brownish-black, speckled between the nervures with orange scales, the fringe of both wings bright orange. The back with two longitudinal bands of crimson, and a tuft at the base of the abdomen, the anus scarlet. The underside bright orange, anterior wings with the base and half the costal margin black, the outer margin dusky; the posteriors black at the base and broadly black at the abdominal margin, the nervures of both wings black. Of the appearance of *hadassa* above but very different beneath.

Mabille & Boullet and Draudt include *creona* among the species having white fringes, but the description states that they are "bright orange." Mabille & Boullet place *aurora* as a synonym of *creona*.

There were no specimens available for examination.

Distribution. Type locality: Peru. (Of *aurora,* the original description says "Bresil," but the Mabille & Boullet paper says "Bolivie."

e. Tegulæ black. Head red. Pectus black.

P. hades (Plate XXXVII, Fig. 31).

Mabille, (Staudinger in lit., *fide* Mabille), Genera Ins., Hesp., p. 9, (notes), 1903.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 178, 182, 1908.

Draudt, Seiz, Macrolep. of the World, vol. 5, p. 840, pl. 162 g, 1921.

The wings blackish-brown on both sides, a little paler on the inner margin of the primaries beneath. Fringes orange-yellow, which may or may not be darkened at the apex of the primaries. On the secondaries there is a marginal orange-yellow band, about as wide as the fringes, beneath the same or a little wider. On the primaries beneath a narrow orange-yellow marginal band. Head, palpi and collar, red. Pectus black. Shoulder-covers black, with a red spot on each side. Tegulæ black. Anal tuft red.

Distribution. Type locality: Bolivia.
Bolivia, Peru (B).

P. amyclas (Plate XXXVII, Fig. 32).

Cramer, Pap. Exot., vol. 3, p. 13, pl. 199, fig. F, 1782.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 178, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, pl. 162 f, 1921.

amiatus Fabricius, Ent. Syst., vol. 3, part I, p. 347, 1793.

laonome Swainson, Zool. Illust., pl. 61, fig. 2, text on following unnumbered page, 1820.

The wings are dark brown on both sides. The fringes orange-yellow, preceded by a marginal band of the same color, that of the secondaries wider and dentate interiorly; that of the pri-

maries a little wider beneath than above. Head, palpi, collar and anal tuft are red. Shoulder-covers black with a red spot on each side. Tegulæ blackish. There is a black spot of variable size on the front of the head before the antennæ. There seems to be considerable variation in the width of the marginal band, the characters of the band mentioned above, are from Surinam specimens and considered typical, agreeing with the Cramer figure. In a male from Venezuela the band is lacking on both sides of the primaries, that of the secondaries being barely indicated above and very narrow below. In a male from Colombia the band is lacking on the primaries above and very narrow beneath, of the secondaries very narrow on both sides, and a female from the same country has much narrower bands than the same sex from Surinam. A male from Bolivia approximates the Colombian male. A male from Santarem, Brazil, has the bands about one-half the width of the Surinam male. The form of the genitalia in these individuals differs only in the termination of the claspers, it being narrow in the Surinam male, a little wider in the Bolivian and still wider in the Brazilian males, but in all essential characters they are the same. The figure here given is from a Surinam male.

Distribution. Type locality: Surinam, Dutch Guiana. Surinam; Bolivia (B). Venezuela; Georgetown, British Guiana; Colombia (A.M.). Santarem, Brazil (A.S.).

P. phylleia (Plate XXXVII, Fig. 33).

Hewitson, Bolivian Butt., p. 20, 1874.

Hewitson, Exot. Butt., vol. v; Pyrrh. & Eryc., pl., fig. 39 (not fig. 38), 1874–1875.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 178, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, pl. 162 g, 1921.

Wings dark purplish-brown on both sides, a little paler on the inner margin of the primaries beneath. Head red in front of the antennæ, in the center back of the antennæ, the sides black. Collar and palpi red. Pectus black. Shoulder-covers black

with a small red spot on each side. Tegulæ black. Anal tuft red. Fringes of the primaries orange-red, intermixed with blackish at the apex; of the secondaries deep red, preceded by a marginal band of the same color, as wide as or a little wider than the fringes. On the underside the marginal band is a little broader and somewhat dentate on the inner edge.

Distribution. Type locality: Bolivia.
Rio Songo, Bolivia (A.S.).

P. haemon.

Godman & Salvin, Biol. Cent.-Amer., Rhop., vol. 2, p. 248, 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 179, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, 1921.

Godman & Salvin say "This species comes close to *phylleia* Hew., of Bolivia, but differs in having a rather wide rufous-orange margin to the secondaries instead of a narrow one as in the allied form. Like *phylleia* it has a red head and black coxæ to the anterior legs, in the former character differing from *P. hadassa* and its allies." There have been no available specimens for examination.

Distribution. Type locality: Costa Rica.

f. Primaries with red or yellow rays.

P. kelita (Plate XXXVII, Fig. 34).

Hewitson, Exot. Butt., vol. iv; Pyrrh., pl. I, figs. 6, 7, 8, 1869.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 177, 183, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, pl. 162 h, 1921.

Wings blackish-brown on both sides. Primaries above with red rays in interspaces 1, 2, sometimes in 3, and in the cell. Secondaries with the outer margin somewhat undulate. Beneath the rays of the primaries are repeated, more extended, and somewhat paler in color. The secondaries beneath with a broad

orange ray in the cell and one in each interspace from immediately below the cell to the costal margin. Fringes orange, darkened at the apex of the primaries. Head, palpi, collar black. Pectus black externally, red internally. Shoulder-covers black with a red spot on each side. Tegulæ black on the lower half, red on the upper Anal tuft red. A red hair tuft at the base of the thorax on each side.

The form of the male genitalia is peculiar and resembles that of *papius* Hopff.

Distribution. Type locality: Apolobamba, Bolivia.
Bolivia (B).

P. kelita form tristis.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 177, 183, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, 1921.

The description states that *tristis* differs from the typical form in the fringes of the forewings being darkened from vein 3 instead of only at the apex, the fringes narrower, the rays narrower and pale orange.

4. Fringes black.

P. thericles.

Mabille, Ann. Soc. Ent. Belg., vol. xxxv, (C. R., ser. iv, pp. cviii–cix), 1891.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, 1921.

The description states that the wings are deep black with a dark blue reflection. Base of the secondaries beneath with a rounded bluish-white spot occupying about one-third of the base of the wing, a little dentate between the nervures. Palpi, vertex and anus scarlet red. Fringe of the primaries black; of the secondaries "rouge obscur." The Mabille & Boullet paper does not quite agree in the color of the fringes, as it places *thericles* in the division "Les 4 ailes a franges noires." The writer has not seen this species.

Distribution. Type locality: "Masauary." Mabille & Boullet say Bolivia.

P. cardus.

Mabille, Ann. Ent. Soc. Belg., vol. xxv, (C. R., ser. iv, p. cviii), 1891.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, 1921.

The description states that the wings are above deep black with a blue reflection. The external border of the primaries strongly sinuate. The secondaries with a small blue spot above and a broad, bluish-white basal spot beneath, cut into unequal spots by the veins. Palpi, vertex and anus scarlet. Occiput and collar black.

There are no specimens of this species at hand.

Distribution. Type locality: Brazil. Mabille & Boullet say Bolivia.

P. hyleus.

Mabille, Ann. Soc. Ent. Belg., vol. xxxv, (C. R., ser. iv, p. cviii), 1891.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, 1921.

The description states that this species resembles *cardus* but is larger and more robust. The secondaries above have a broad, rounded bluish-white spot, and beneath a broad white basal spot separated from the body by black and extended on the veins to beyond the cell where it is colored more bluish. Palpi, head and anus red. Mabille & Boullet place this species and *cardus* in the division having black fringes on all wings, the descriptions of the two do not mention the color. Mabille and Boullet mention only one large white spot which we assume refers to the one on the underside of the secondaries. They also misspell the name "*hyloeus*" on page 181.

Distribution. Type locality: "Itaituba." Mabille and Boullet say Bolivia.

GROUP B. *P. scylla* section

Genitalia. Included in this group are those species having the same form in the male genitalia as that of *scylla* Menetries. The uncus terminates in a single, down-curved point. The flanges at the base of the uncus are short, usually somewhat roundish, serrate and shagreened. The girdle and saccus are shorter than in group A. The œdœagus is rather short, stout, and turned downward and pointed at the tip, with a collar-like girdle. The claspers are practically symmetrical and terminate in a long arm, usually curved, tapering and pointed at the apex, with numerous serrations on either or both dorsal and ventral edges and more or less shagreened on the sides. The upward projections from the dorsal edge, at the base of the terminal arm of the claspers, are usually not present in this group. There is a great similarity in the genitalia in some of the species in this group which are readily separated on their superficial characters.

1. Fringes white.
   a. Pectus black.

P. scylla (Plate XXXVII, Fig. 35).

Menetries, Enum. Corp. Anim. Musei Imp. Acad. Scient. Petrop., part 1, p. 95, pl. 4, fig. 7, 1855.

Godman & Salvin, Biol. Cent.-Amer., Rhop., vol. 2, pp. 249, 250; vol. 3, pl. lxxiii, figs. 5, 6, 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 173, 179, 1908; (this reference cannot apply to *scylla* Menetries).

Draudt, Seitz, Macrolep. of the World, vol. 5, pl. 162 a, 1921; (neither the text nor the figure apply to *scylla* Menetries).

dulcinea Plotz, Stett. Ent. Zeit., vol. xl, p. 532, 1879.

Mabille and Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 c, 1921.

Godman and Salvin are undoubtedly correct in their determination of *scylla* Menetries and their application of the name is followed in this paper. The wings are greenish-black. Fringes white, sometimes preceded by a narrow white marginal stripe on the secondaries. Head black with white spots and lines. Palpi red, bordered with black internally, which may be reduced to central black spot on the inner edge. The collar seems to vary somewhat, from red bordered with white externally to black intermixed with red and bordered with white externally. Pectus black. Shoulder-covers red. Tegulæ varying considerably, they may be black with a red, orange or yellow spot at the base and the upper side edged with red, orange or yellow, or with greenish-white (*dulcinea* Plotz), or they may be entirely dark. The anal tuft red. Thorax above with a greenish-white line on each side. The Biologia figure represents the typical form. *Dulcinea* Plotz might be used for the form with the greenish-white lines of the tegulæ but there seems little point in doing so in view of the wide variation in this character and Godman & Salvin are followed here in placing it as a synonym of *scylla*. As noted previously in this paper, the Mabille and Boullet, and Draudt references to *scylla* seem to apply to the insect we have identified as *papius* Hopffer.

Distribution. Type locality: Nicaragua. Of *dulcinea* Plotz: Panama.
Mexico; Guatemala; Honduras; Nicaragua; Panama; Colombia; Venezuela (G. & S.). Iguala, Mexico; Peru (?), (B).
N. Mexico; Petuc, Honduras; Sta. Catharina, Brazil (?) (A.M.).

P. menecrates (Plate XXXVIII, Fig. 36).

Mabille, Ann. Soc. Ent. Belg., vol. xxi, p. 13, 1878.
Godman & Salvin, Biol.-Cent. Amer., Rhop., vol. 2, pp. 248, 249, 1893.
Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 174, 180, 1908.
Draudt, Seitz, Macrolep. of the World, vol. 5, p. 837, pl. 162 b, 1921.

Wings on both sides with a bluish-green or greenish sheen. The primaries beneath tinted violaceous on the inner margin. Fringes white. Head, palpi, collar, shoulder-covers and anal tuft, red. Pectus black. Tegulæ black with a red spot at the base. In an individual from Bolivia there is an accumulation of pale brown and whitish scales on both sides of vein 1 toward the base, on the underside of the primaries, and also a few scattered bluish scales below the costal vein in the basal third; the form of the genitalia in this specimen does not essentially differ from that of the other specimens.

Distribution. Type locality: Peru.
Brazil; Bolivia (Mab. & Boull.). Honduras; Colombia; Venezuela; Peru; south Brazil (G. & S.).
Villarica, Paraguay; Santa Cruz, Bolivia (B).

b. Pectus red.

P. adonis new species (Plate XXXVIII, Fig. 37).

Primaries and secondaries greenish-black on both sides. Fringes white, of the secondaries crenate. Head, palpi, collar, shoulder-covers, pectus and anal tuft, red. The head has a large black spot in front of, and a black transverse line behind, the antennæ. Tegulæ black, with a few red hairs at the extreme base. Body black, above and beneath. Legs black, with red hairs intermixed on the femora and tibiæ.

Expanse: 58–62 mm.

Type material: Holotype male, Villarica, Paraguay, November, in collection of the author. Paratypes, 1 male, Villarica, Paraguay; 1 male, Santa Catharina, Brazil, in collection of the author; 2 males, Brazil, in collection of the American Museum of Natural History, New York City. The terminal arm of the claspers differs from that of *scylla in* being produced directly outward and somewhat sinuous instead of being curved, serrate only on the dorsal edge, and bearing at the base an upright, serrate flange. The flanges at the base of the uncus are somewhat elongate, instead of rounded.

P. mariæ new species (Plate XXXVIII, Fig. 38).

Primaries and secondaries on both sides shining greenish-black, the inner margin of the primaries somewhat violaceous beneath. Fringes white, or intermixed with dark scales on the primaries toward the apex. Outer mar-

gin of the secondaries crenate. Head carmine, with a black transverse line in front of the antennæ and another one behind. The palpi are carmine, black at the tip, giving the appearance of a black bar across the front of the head. Collar carmine. Pectus blue-black with a small patch of red hairs at the base, and a few scattered red hairs running part way down the center. Tegulæ black. Anal tuft carmine. Female larger but otherwise the same.

Expanse: male, 54 mm.; female, 68 mm.

Type material. Holotype male, Rio Grande do Sul, Brazil; allotype female, Hansa Humboldt, Santa Catharina, Brazil. Paratypes, 1 male, Rio Grande do Sul, Brazil; 1 male, Masranduba-Blumenau, Brazil, in collection of the author.

This species has much the same general appearance as *adonis*, but is smaller (at least in the males) and differs superficially in the characters mentioned in the description as well as in the form of the claspers in the genitalia, in these the terminal arm is rather short and ends in a double pointed lobe, somewhat like the tail of a fish, and is serrate on the outer edge.

This handsome species is named for Mrs. E. I. Huntington.

c. With white basal band of primaries and secondaries, beneath.

P. fluminis (Plate XXXVIII, Fig. 39).

Butler, Cist. Ent., vol. 1, p. 176, 1873.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175, 180, 1908; (as *bixæ* Cramer, not *fluminis* Butler).

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, 1921; (as *bixæ* Cramer, not *fluminis* Butler).

bixæ Cramer (not Linnæus), Pap. Exot., vol. 3, p. 12, pl. 199, figs. C, D, 1780.

tiribazus Plotz, t. 1277; (fide Mabille & Boullet). Description unpublished?

Cramer refers the insect he figured to *bixæ* Linnæus, a name which is now applied to an African *Rhopalocampta*. Butler realizing that the name "*Papilio bixæ*" applied by Cramer to this insect could not hold, as it would be a homonyn of the earlier "*Papilio bixæ*" of Linnæus, redescribed it as *fluminis*, and he states in his description that *bixæ* Cramer is a synonym. Cramer

states in his remarks that the specimen figured is a female. The figure shows an insect with apparently entirely white fringes. Capt. Riley, of the British Museum, writes, that Butler's type in the museum collection has entirely white fringes and very well agrees with the Cramer figure of *bixæ* and that it is the only specimen in the collection which does agree in having entirely white fringes. Butler's type of *fluminis* has a broad white basal band on both primaries and secondaries beneath, which is approximately of the same width on both wings.

There are no female specimens before the writer and no specimens with entirely white fringes, a character which is probably variable. The insect to which the name *fluminis* is applied in this paper is bluish or greenish-black, with a red head on which there is a black spot, varying in size, before the antennæ; collar, palpi and anus red; pectus, shoulder-covers and tegulæ blue-black; fringes white, more or less darkened toward the apex of primaries, finely marked with black at the vein ends in the upper part of the primaries and sometimes at the outer and anal angles of the secondaries. Both primaries and secondaries have a white basal band beneath, very broad in specimens from Colombia, French Guiana and Chapada, Brazil, narrower in those from Ecuador which closely agree with the Draudt figure of *intersecta* Herrich-Schaffer (Seitz, Macrolep. of the World, vol. 5, pl. 162 c). The form of the genitalia is the same in the specimens from the various localities. There are two male specimens at hand which are taken to be aberrations of *fluminis*, one of these from Chapada, Brazil, in the collection of the Academy of Sciences, Philadelphia, has no white basal band on the secondaries but in the area usually occupied by the band there are a few widely scattered pale bluish-white scales and on the primaries the band is much broken. consisting of a few white scales above the costal vein, a long streak below it, a spot at the base of the cell and another divided by vein 1. The other specimen from Bogota, Colombia, in the collection of the writer lacks all trace of the white basal band of the secondaries, that of the primaries being represented by only a few bluish scales below the costal vein. The form of the genitalia of these two does not differ from that of the prominently banded individuals.

The insect referred to *fluminis* Butler by both Mabille & Boullet and Draudt appears to be the one described as *draudti* in Group A of this paper.

Distribution. Type locality: "Santarem (Bates); Archidona (B.M.)" (*fluminis* Butler).
Surinam (*bixæ* Cramer).
Colombia, French Guiana, Ecuador, (B).
Chapada, Brazil, (A.S.).
Amazon, (A.M.).

P. intersecta.

Herrich-Schaffer, Corresp.-blatt Zool.-Mineral. ver, Regensb. vol. xxiii, p. 166, 1869. (Prodr. Syst. Lep., part 3, p. 58, 1869.)

Plotz, Stett. Ent. Zeit., vol. xl, p. 533, 1879.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 c, 1921.

Herrich-Schaffer's description is too brief to be of real use. He describes *intersecta* in the genus *Myscelus* which he separates from the genus *Pyrrhopyge* by "Saum der Hfl. mehr oder weniger gezacht, auf den R dunkler" and the description reads "O S ganz schwarz, unbezeichnet." Plotz states that both wings beneath are dusted with white toward the base, the fringes of the hindwings sometimes finely speckled with black, and cites "Pl. t. 1275." The characters given by Plotz are more or less followed by Mabille & Boullet and Draudt. As it is stated in the preface of the Seitz, Macrolep. of the World, vol. 5, p. vii, that many of the figures published in that volume were copied from the Plotz drawings, it may be that the figure of *intersecta* on plate 162 c correctly portrays the Herrich-Schaffer species. This figure seems to closely resemble specimens at hand from Ecuador which the writer believes to be *fluminis* Butler with somewhat narrower white basal bands on the underside of the secondaries and not entirely white fringes, as mentioned in the remarks under that species. The Herrich-Schaffer description of *intersecta* antedates that of Butler's *fluminis* but as there

seems to be no positive evidence at hand that the two names refer to the same species, it is probably better that both be retained.

Distribution. Herrich-Schaffer gives no locality for the type. Plotz gives Peru, and Mabille & Boullet give Colombia and Ecuador.

P. semidentata.

Mabille, Petit Nouvelles Ent., pp. 161, 162, 1877.

Mabille, Ann. Soc. Ent. Belg., vol. xxi, p. 14, 1878.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175, 180, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, 1921.

There are two specimens before the writer which fairly well agree with the description of *semidentata* and there seems to be nothing to distinguish these from *flumnis* Butler except the progressive darkening of the fringes of the primaries and the more markedly interested fringes of the secondaries. In one specimen the collar is blue-black and in the other it is red. The form of the genitalia does not differ from that given in this paper for *fluminis* Butler.

Distribution. Type locality: E. Peru. Colombia (Mabille & Boullet). New Granada; Bolivia (Mabille). Upper Amazons; Matto Grosso (B.M.). Manicore, Brazil; Corumba; Matto Grosso (B).

2. Fringes yellow.

P. carriæ new species (Plate XXXVIII, Fig. 40).

Male. Upperside. Wings greenish-black, with an antemarginal yellow band on the secondaries, broader in the center than at the two ends and almost crossed by the black veins. Beneath. Same color as above, inner margin and base of primaries violaceous brown; secondaries with rather long black hairs at the base and which extend into the discal area, the yellow antemarginal band same as above and carried on the primaries as a very fine line. Fringes yellow on both wings. Head, palpi, collar and abdominal apex red. Shoulder-covers red with the extreme ends at each side black. Tegulæ blue-black with a red spot at the base. Pectus blue-black.

Expanse: 58 mm.

Type material. Holotype male, Sapucay, Paraguay, February (Heinrich), in collection of the Academy of Natural Sciences,

Philadelphia, Penna. Named for Mrs. R. C. Williams, Jr. This species differs from the description of *josephina* Draudt in that the fringes are decidedly yellow (not white tinted with yellow), the antemarginal band of the secondaries is almost crossed by the black veins, the red shoulder covers, and the red spot on the tegulæ.

Carriæ resembles *pelota* but is larger, the pectus is black instead of red and the form of the genitalia is very different.

GROUP C. *P. hygieia* section

Genitalia. Included in this group are those species having the same form in the male genitalia as that of *hygieia* Felder. The uncus terminates in two separate and pointed arms, somewhat bent downward and with a short, pointed projection between them. There is a short, round flange on each side of the uncus at the base. The scaphium is present. The girdle varies from long to rather short and the saccus also varies in length. The aedoeagus has a bulbous swelling at about one-quarter of its length from the base, from which it tapers toward the apex; before the apex there is a short, pointed flange. The claspers terminate in a rather long, slightly curved arm, serrate on the dorsal edge, the tip upturned and the extreme apex pointed, rounded or blunt. There is occasionally some asymmetry in the terminal arms. At the dorsal base of the arm is an upward projection which is sometimes very long and curved and serrate at the tip (*rufipectus, zereda, apollo*). *Aesculapus* and *chalybea* differ somewhat in that the arm of the claspers is more curved upward and the apex rounded.

a. Pectus black. Palpi red.

P. hygieia.

Felder, Reise Novar., Lep., vol. 2, p. 506, pl. 70, fig. 1, 1866.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 177, 182, 1908. (as *bogotana Reakirt,* not *hygieia* Felder.)

bogotana Reakirt, Proc. Acad. Nat. Sciences, Phila., p. 90, 1868.

The description states that the wings above are steel-blue, darkened at the external margin, secondaries with the posterior margin orange-red, crenate within. Wings darker beneath, primaries with the inner part fuscous, secondaries with the posterior margin paler and a little broader than above. Fringes fuscous. Palpi red. The figure shows the head, collar, shoulder-covers and tegulæ dark. As the color of the pectus is not mentioned in the description of either *hygieia* or *bogotana* it is assumed that it is not red. The Draudt reference mentioned above seems to refer to *rufipectus* Godman & Salvin and not to *hygieia* Felder.

Distribution. Type locality: "Nova Granada: Bogota"; (*hygieia*).
"Insagasuga, New Granada"; (*bogotana*).

b. Pectus black. Palpi black with the tip red.

P. phoebus.

Rober, Ent. Mitteil, vol. xiv, p. 86, 1925.

The description states that the band of the secondaries is a little shorter and considerably broader toward the anal angle than in *hyfieia*. Front legs not red. Palpi with only the distal section red. Collar not red. The brief description indicates that *phoebus* differs from *hygieia* not only in the extent of the marginal band of the secondaries but in that only part of the palpi is red.

Distribution. Type locality: "Kolumbien (Cauca-Tal)."

c. Pectus red. Palpi black.

P. zereda.

Hewitson, Trans. Ent. Soc. London, third series, vol. 2, p. 484, 1866. (not Exot. Butt., vol. iv, Pyrrh. pl. ii, fig. 13, 1871).

Godman & Salvin, Biol. Centr.-Amer., Rhop., vol. 2, pp. 250, 251, 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, p. 182 (not p. 178) 1908.

rufinucha Godman & Salvin, Proc. Zool. Soc., London, pp. 151, 152, 1879; (not *rufipectus* Godman & Salvin, Proc. Zool. Soc., London, p. 152, 1879).

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 177, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, pl. 162 f, 1921.

Hewitson's description states "Upperside, female, glossy blue; the posterior wing bordered with orange; the neck with a few scarlet hairs." Godman and Salvin say "On an examination of the Hewitson collection we find that the name *P. zereda* was applied to a species allied to *P. hygieia* Feld. which we subsequently described as *P. rufipectus* (P. Z. S. 1879, p. 152)." It is the belief of the writer that the statement of Godman & Salvin that *zereda* is the species which they described as *rufipectus* is an error and that they intended to say *rufinucha* as both species were described in the same paper, *rufinucha* first and *rufipectus* immediately following and on account of their similarity might easily be transposed, this seems all the more probable in view of the fact that Hewitson's description mentions the scarlet hairs on the neck, a characteristic of *rufinucha* but not of *rufipectus*. Hewitson describes only the upper side of *zereda*, but as both *rufinucha* and *rufipectus* have a red pectus, which is mentioned in the description of each, it seems safe to assume that *zereda* also has a red pectus. The specimen before the writer, which is identified as *zereda* has a brilliant blue sheen to the wings, on both sides. The secondaries have a narrow orange marginal band cut short before the outer angle and dentate internally. The fringes of the primaries are black; of the secondaries red as far as the band extends, above that black. Head, palpi, shoulder-covers, tegulæ, anus and legs are black or blue-black. Collar and pectus red. The Mabille & Boullet reference, (Ann. des Sciences Nat., Paris, p. 178, 1908), seems to refer to some other species. The Draudt reference, (Seitz, p. 840, pl. 162 f), seems to refer to the female of *P. chalybea* Scudder, although the locality given, "Ecuador," is outside the range of *chalybea* it is probably incorrect.

Distribution. Type locality: Ecuador. Bolivia (*rufinucha*). Peru (?) (B).

The form of the genitalia is very similar to that of *rufipectus*, (Fig. 41).

P. rufipectus (Plate XXXVIII, Fig. 41).

Godman & Salvin, Proc. Zool. Soc., London, p. 152, 1879.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, p. 182, 1908; (as synonym of *zereda* Hewitson).

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, 1921; (as synonym of *zereda* Hewitson).

The color of the wings and fringes is the same as in *zereda*, but the marginal band of the secondaries is much broader and there is no red on the collar. The head, palpi, shoulder-covers, collar, tegulæ and anus are black or blue-black. Pectus red. The action of Mabille & Boullet and Draudt in placing *rufipectus* as a synonym of *zereda* Hewitson, probably follows the Godman & Salvin action in the Biologia, which the writer believes to be incorrect as stated in the remarks under *zereda*. It seems probable that the characters given for *hygieia*, by Mabille & Boullet, (Ann. des Sciences Nat., Paris, p. 177, 1908) as well as their records of specimens (p. 182), refer to *rufipectus*.

Distribution. Type locality: Rio Topo, Ecuador (A.M.) (B.).

P. apollo (Plate XXXVIII, Fig. 42).

Rober, Ent. Mitteil., vol. xiv, p. 86, 1925.

There is a specimen in the collection of the writer, from the Fassl collection, which bears the locality label agreeing with the type locality cited for *apollo*, and which agrees with the characters of maculation given in the description. The wings are the same color as in *zereda* Hewitson (not *chalybea* Scudder) and in *rufipectus* Godman & Salvin. The orange marginal band of the secondaries is narrow, and prolonged to near the outer angle, instead of being cut short before that point. The head, palpi, shoulder-covers, tegulæ and anus are black or blue-black. The pectus and collar are red. The Draudt figure of *rufinucha* Godman & Salvin (Seitz, pl. 162 f) looks very much like *apollo* Rober, the orange fringes being carried still further upward.

The genitalia are similar in form to *zereda* Hewitson and *rufipectus* Godman & Salvin, in the single specimen available for examination the dorsal upward projection at the base of the terminal arm of the claspers is much shorter, whether this is a

constant character cannot be determined until more material is available.

Distribution. Type locality: "Bolivia (Rio Songo, 750 mm., A. H. Fassl)."

d. Pectus black. Palpi black.

P. aesculapus (Plate XXXVIII, Fig. 43).

Staudinger, Verh. Zool. Gesel., Wien, vol. xxv, pp. 112, 113, 1875.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, p. 251, vol. 3, pl. lxxiii, fig. 9, male genit., 1893; (as *æsculapius*).

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 177, 182, 1908; (as *æsculapius*).

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, pl. 162 f, 1921; (as *æsculapius*).

variegaticeps Godman & Salvin, Proc. Zool. Soc.. London, p. 152, 1879.

Wings with a glistening blue sheen, secondaries somewhat darker on the upper side. Fringes of primaries black, sometimes with a few red scales near the anal angle; of the secondaries red. Head black with white lines. Palpi black. Collar and shoulder-covers black with a few white hairs. Tegulæ black with a few white hairs at the extreme base. Godman and Salvin place *variegaticeps* as a synonym of *æsculapus*.

Distribution. Type locality: Chiriqui, Panama. Costa Rica (*variegaticeps*).
San Jose, Costa Rica (B).

P. insana.

Staudinger, Verh. Zool. Gesel., Wien, vol. xxv, p. 113, 1875.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 177, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, 1921.

The original description says that the wings are black glazed with steel green or blue. Head, breast and palpi black. The

hindwings with a narrow orange border to beyond the middle. The description does not state the color of the collar but Boullet in his description of *P. fassli* says that *insana* has a red collar.

Distribution. Type locality: Peru.

P. fassli.

Boullet, Bull. Soc. Ent., France, pp. 59, 60, 1910.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, 1921.

The description states that the wings are a brilliant blue with a green reflection, a moderate black border on the primaries, the secondaries with a rather broad red band extending almost to vein 7. The fringe of the primaries is lightly mixed with red-orange. Anterior thighs and palpi black. Differs from *insana* Staudinger in the collar being black and not red as in that species.

Distribution. Type locality: Huancabamba, Peru; Bolivia; Colombia.

P. chalybea (Plate XXXVIII, Fig. 44).

Scudder, Rept., Peabody Acad. of Sciences, (for 1871), p. 67, 1872.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, pp. 250, 251; vol. 3, pl. lxxiii, fig. 12, male genit., 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 178, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 840, pl. 162 g, 1921.

zereda Hewitson, Exot. Butt., vol. iv, Pyrrh. pl. ii, fig. 13, 1871; (not Trans. Ent. Soc., London, third series, vol. 2, p. 484, 1866).

The primaries are metallic green and the secondaries metallic blue. Fringes of both wings orange. Secondaries with a marginal orange band, broadest at the anal angle, dentate interiorly. Head, palpi, pectus, collar and tegulæ are dark bluish. The legs have the femora striped with orange.

Hewitson's original description of *zereda* does not apply to *chalybea* and the type locality of *zereda* is given as Ecuador

whereas *chalybea* is a Mexican insect. *Zereda* is apparently a good species but in any event the name having been applied to one insect cannot be shifted to another in the same genus. As mentioned by Godman & Salvin the claspers are not quite symmetrical. The left clasper is represented in fig 44, the right clasper is like the Biologia figure.

Distribution. Type locality: Mexico. Guadalajuara; Mexico City, Mexico (B).

P. jonas.

Felder, Wien Ent. Mon., vol. iii, p. 328, 1859.
Hopffer, Stett. Ent. Zeit., vol. xxxv, p. 371, 1874.
Plotz, Stett. Ent. Zeit., vol. xl, p. 534, 1879.
Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, p. 250; vol. 3, pl. lxxiii, figs. 7, 8 male genital., 1893.
Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.
Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, pl. 162 e, 1921.
cydonia Druce, Cist. Ent., vol. 1, p. 289, 1874.

The wings are dark blue, head black intermixed with fulvous in front. Palpi and abdominal apex fulvous. Fringes white. Outer margin of the secondaries rounded and dentate.

Jonas is included in this group although it does not agree very well with the other members in the general superficial appearance, and the form of the male genitalia, while differing somewhat, seems to be more closely associated here than in any of the other groups.

Distribution. Type locality: Mexico. Mexico; Guatemala (G. & S.).
Oaxaca, Mexico (*cydonia*).

GROUP D. *P. creon* section

Genitalia. Included in this group are the species which seem to be allied to *creon* Druce in their general superficial characteristics; *creon*, however, is the only species placed in this group, of which material has been available for examination of the genitalia. The uncus of *creon* is peculiar in the somewhat bulbous

termination furnished with a bifid beak-like projection. The girdle is of moderate length, the saccus short. The aedoeagus rather short. The claspers terminate in a long, narrow arm, serrate toward and at the tip, somewhat upward curved and with a little asymmetry. There is a short upward projection, serrate at the tip, near the base of the arm.

P. creon (Plate XXXVIII, Fig. 45).

Druce, Cist. Ent., vol. I, p. 289, 1874.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, p. 251; vol. 3, pl. lxxiii, fig. 10, 11 male genital., 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, pl. 162 e, 1921.

cyclops Staudinger, Verh. Zool. Gesel., Wien, vol. xxv, p. 114, 1875.

The wings above are a shining dark blue with a blackish outer border. Beneath much the same, paler on the inner marginal area of the primaries. A red spot on the secondaries near the anal angle, repeated on the under side. Head, collar and palpi are black. Shoulder-covers, tegulæ and pectus are blue-black.

Distribution. Type locality: "Calobre, Veragua." Chiriqui (*cyclops*).
Costa Rica; Panama (G. & S.). Honduras; Costa Rica; Colombia (Mabille & Boullet). San Jose, Costa Rica (B).

P. sangaris.

Skinner, Ent. News, vol. xxxii, pp. 236, 237, 1921.

The description states that the upper side of the primaries is a shining green-black; secondaries the same, but somewhat darker and with a blood-red quadrate spot near the anal angle. Beneath the same, the spot of the secondaries somewhat smaller and rounded. Palpi crimson, with the tip black.

Abdomen and legs dark green-black.

Distribution. Type locality: "Hacienda Cincinnati, Sierra San Lorenzo, Magdalena, Colombia."

P. aerata.

Godman & Salvin, Proc. Zool. Soc., London, p. 152, pl. 14, fig. 3, 1879.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 177, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, pl. 166 a, 1921.

The description states that the wings on the upper side are bronzy-green, the secondaries darker, with a discocellular and three adjoining rufous spots. Beneath the wings are bronzy-green, the three spots of the secondaries forming a rufous patch in the middle. Body greenish-black, the abdomen with six rufous bands on either side.

Distribution. Type locality: "Pueblo Viejo, Sierra Nevada de Santa Marta."

GROUP E. *P. agenoria* section

Genitalia. This group contains those species in which the form of the genitalia is similar to that of *P. agenoria* Hewitson. The uncus terminates in a long, slender, down-curved tip. The girdle is rather short and the saccus moderate in length. The aedoeagus is very long, the shape differing among the species. The claspers are bifid at the termination, one or both or neither of the two parts may be serrate.

1. Anal angle of secondaries red.

a. Basal area of secondaries beneath not white.

P. agenoria (Plate XXXVIII, Fig. 46).

Hewitson, Ent. Monthly Magazine, vol. 12, p. 251, 1876.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 d, 1921.

In the insect here treated as *agenoria* the color of the wings is a dark brown with a slight sheen, the anal angle of the secondaries red. The fringes are white, darkened in the apical half of the primaries and red at the anal angle of the secondaries. The head is black with a white line just above the palpi,

three white spots in a line in front of the antennæ and a very narrow white line in back of the antennæ. The palpi are blackish-brown. The collar dark brown with a narrow white line. Shoulder-covers red. Tegulæ blackish-brown. Pectus black.

In *agenoria* and the males of the other species in this group, that have been available for examination by the writer, there is a more or less distinct projection on the outer margin of the secondaries, above the anal angle. This projection is lacking in the females.

The figure of the genitalia is from a specimen said to have come from Colombia but the writer is not sure that this is correct, however, the specimen agrees with another individual, in his collection, from Peru.

Distribution. Type locality: Chanchamayo, Peru. Peru; Colombia (?) (B).

P. styx (Plate XXXIX, Fig. 47).

Moschler, Verh. Zool. Gesel., Wien, vol. xxviii, p. 113, 1878.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 166 a, 1921.

anina Plotz, Stett. Ent. Zeit., vol. xl, p. 533, 1879; (as synonym of *styx* Moschler).

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, p. 181, 1908.

There are no specimens before the writer from the type locality (Colombia) but a Bolivian specimen agrees very well with the description and shows the following characters. The wings are greenish-black above and beneath. The secondaries with the anal angle broadly red. Fringes white, blackened toward the apex of the primaries and red at the anal angle of the secondaries. Head, palpi, collar and anal extremity red. Pectus, shoulder-covers and tegulæ blue-black.

Plotz himself places his *anina* as a synonym of *styx* Moschler and apparently published no description but Mabille and Boullet for some reason list *anina* as a separate species.

Distribution. Type locality: Colombia. Chapada, Brazil (A. S.).
Santa Cruz, Bolivia (B).

P. cruor.

Druce, Trans. Ent. Soc., London, part 2, p. 378, pl. xxi, fig. 2, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 166 a, 1921.

The description states that the wings are indigo blue shading to green. Anal angle of hind wing rich red. Fringes white except apex of primaries black and anal angle of secondaries red. The primaries have a broad band of modified scales before the center, which are darker than the ground color and extend from the sub-costal nervure, where it is broadest, to the sub-median nervure where it terminates pointedly. Palpi black. Head black with a long white frontal spot and white spots at the base of the antennæ and between the eyes. Collar dark red. Underside as above with the transverse fascia of the primaries repeated and widened beyond the end of the cell.

Although the description states that the "collar" is red the figure indicates that this part is that which is referred to in this paper as the "shoulder-covers."

Distribution. Type locality: Pozuzu, Peru.

P. sanies.

Druce, Trans. Ent. Soc., London, part 2, p. 378, pl. xxi, fig. 3, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 164 d, 1921.

The description states that the upper side is rich dark brown, with bluish reflections. Primaries with a semi-hyaline white fascia extending from the sub-costal nervure broadly to the submedian, where it ends pointedly, and is divided into three spots by the black median nervules. Fringes of primaries white, blackened toward the apex; of the secondaries white, with the anal angle red. Palpi black. Head black with a white frontal spot and white spots between and at the antennae. Collar red.

Abdomen concolorous with the wings, and with two minute white spots beneath at the base of the anal segment.

As in *cruor* the figure shows that the part termed in this paper as the "shoulder-covers" is red and not the "collar."

Distribution. Type locality: Farinas, La Paz, Bolivia.

b. Basal area of either or both wings beneath, white.

P. **passova** (Plate XXXIX, Fig. 48).

Hewitson, Trans. Ent. Soc., London, third series, vol. 2, p. 482, 1866.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 d, 1921.

The description states that the upper side is green-black. Anal angle of the secondaries scarlet. Beneath the base of both wings is broadly white. Fore head, palpi and anus are scarlet. There are two specimens, a male and a female, from Peru, before the writer, the female has the basal area of both primaries and secondaries white, but the male has a white basal area of the secondaries only, the base of the primaries being entirely black, as in the Draudt figure, all of the other characteristics, however, agree with the description. This male, from which the accompanying figure of the genitalia was made, may be merely a variation from typical *passova*. Unfortunately the genitalia of this specimen was very much malformed, so only one clasper and the ædoeagus could be figured.

Distribution. Type locality: "Amazon (Ega) and Cayenne." Perene, Peru (A. S.). Peru (B).

P. **gortyna**.

Hewitson, Trans. Ent. Soc., London, third series, vol. 2, p. 483, 1866.

Hewitson, Exot. Butt., vol. iv, Pyrrh. pl. iii, fig. 21, 1871.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 166 a, 1921.

The description states that the wings are black on the upper side; secondaries with a large white spot at the apex and the anal angle scarlet. Beneath, secondaries with the basal half white. Fore head, palpi and anus scarlet.

Distribution. Type locality: "Amazon (Ega)."

2. Anal angle of secondaries not red. Secondaries with a marginal row of metallic spots. Fringes white.

P. gellias.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, p. 248, 1893; vol. 3, pl. cxii, figs. 1, 2, 1906.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 175. 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 d, 1921.

The description states that the wings are dark olive above, the secondaries elongate and with a projection at the end of the first median branch, and with a sub-marginal dark olive fascia divided by the dark veins. Beneath unicolorous dark olive, primaries toward the base and secondaries in the center with dark hairs. Head, palpi, anterior coxæ and abdominal apex fulvous-red.

Distribution. Type locality: Costa Rica. Chiriqui, Panama (G. & S.).

P. gazera.

Hewitson, Trans. Ent. Soc., London, third series, vol. 2, p. 482, 1866.

Hewitson, Exot. Butt.. vol. iv, Pyrrh. pl. iii, fig. 20, 1871.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, p. 248, 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 838, pl. 162 d, 1921.

The description states that the wings are black above, the primaries glossed with green at the costal margin; secondaries with a marginal band of glossy blue. Beneath blue-black with black hair near the base of both wings. Fringes white. Head, palpi and anus scarlet.

Distribution. Type locality: "Amazon (St. Paulo)."

P. ganymedes new species (Plate XXXIX, Fig. 49).

Male. Upper side. Primaries black with a slight greenish sheen. Secondaries black with a marginal band of triangular blue-green spots between the veins. The abdominal fold is bordered interiorly with rather long black hairs which also extend over the basal and discal areas of the wing. The secondaries are somewhat elongate and have a distinct projection in the outer margin above the anal angle. Beneath, greenish-black, a little paler at the base and inner margin of the primaries. The secondaries with a white basal band occupying about one-third of the wing; rather even in width but not sharply defined on the outer edge. Fringes white, darkened in the apical area of the primaries. Head red, except the extreme rear which is black. Palpi and anus red. Collar, shoulder-covers pectus, and tegulæ are blue-black. Body and legs blue-black, the hind legs fringed with pale brown.

Expanse: 56 mm.

Type material. Holotype male, Colombia, in collection of the Academy of Natural Sciences, Philadelphia, Penna.

3. Fringes orange. No marginal band of metallic spots on the secondaries.

P. fleximargo (Plate XXXIX, Fig. 50).

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 178, 182, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 841, 1921.

There is a single male specimen from Mapiri, Bolivia, before the writer, which agrees with the description except in the color of the head, which appears to have been attached, so it is not certain that it is the correct one. The wings above are brown with an olive sheen, the veins showing through in darker color; beneath paler and with less sheen. The fringes are orange and preceded by a marginal band of the same color, narrow on the primaries and wider on the secondaries; approximately the same on both sides of the wings. The secondaries have the projection of the outer margin above the anal angle. Pectus black. Shoulder-covers and tegulæ brownish. The description states that the head is red, with the occiput blackish.

Distribution. Type locality: Bolivia.

MISCELLANEOUS

P. boulleti.

Le Cerf, Bull. du Mus. Nat. d'Hist. Naturelle, Paris, p. 162, 1922.

The description states that the wings are shining greenish-black, the primaries with three groups of transverse, dark saffron-yellow hyaline spots: a narrow median band divided into three by the nervules, obliquely from the radial nervule to nervure 1b, curved inward above the cell; a short parallel discal band beginning at nervure 5 to the middle of nervure 3; two apical spots between 6 and 7. Beneath duller, purplish at the base, with the markings less dark than above, except the spot in the cell. Fringes black. Head and palpi red-brown, with a transverse line before the vertex, at the sides in front, and the third segment of the palpi black. Antennæ, body and legs are greenish-black. Last sternite bordered with red. Anal extremity missing but red hairs remaining indicate that it is more or less of this color. The writer is unfamiliar with this species and is unable to place it in any of the foregoing groups; from the superficial characters given in the description it may be more closely affiliated with some other genus in the *Pyrrhopyginæ*.

Distribution. Type locality: "Near Pampelona, Colombia."

P. galgala.

Hewitson, Trans. Ent. Soc., London, third series, vol. 2, p. 483, 1866.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, pp. 253, 256, 257, 1893.

Godman & Salvin refer *galgala* to the genus *Mysoria*, although they note that the venation does not quite agree with it. The form the male genitalia differs from that of the various groups of *Pyrrhopyge* dealt with in this paper. The writer follows Godman & Salvin in considering *galgala* to be better placed in the genus *Mysoria*.

P. fimbriata.

Plotz, Stett. Ent. Zeit., vol. xliii, p. 322, 1882.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, p. 636, 1901.

Godman, Ann. and Mag. Nat. History, series 7, vol. xx, p. 138, 1907.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, p. 178, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, pp. 840, 975, 1003, 1921–1924.

It seems extremely doubtful that *fimbriata* belongs anywhere in the *Pyrrhopyginae.* Plotz was certainly a keen enough student of *Hesperiidae* to have placed *fimbriata* in the *Pyrrhopyginae* if it belonged there, instead of in *Hesperia* as he did. Godman and Salvin place it among the unidentified Plotz species. Godman, in his notes on the Plotz species says "Unknown to me," and it is more than likely that if he thought it to be a *Pyrrhopyge,* he would have said so. Draudt includes it in the genus *Pyrrhopyge,* probably because Mabille & Boullet did so, and again, questionably, in the genus *Megistias;* and in the "List of American Hesperidæ," (p. 1003), gives for the *Megistias* reference "Exot. Schmett. 20, Hesperid, Tab. 301." and for the *Pyrrhopgye* reference "Stett. Ent. Ztg. 43, p. 321." Plotz, in the Stett. Ent. Zeit. reference describes *fimbriata* as a *Hesperia* and quotes "Pl. Hesp. t. 301." The two Draudt references therefore are the same thing. The expanse given by Plotz for *fimbriata,* "17 mm." would indicate a very small species for a *Pyrrhopyge* which are quite large and robust insects. While there is no apparent certainty that *fimbriata* belongs in the genus *Megistias,* it is probably much nearer to its true affiliation there than in the genus *Pyrrhopyge.*

Distribution. Type locality: Mexico.

APYRROTHRIX

Lindsey, Univ. of Iowa Studies, vol. ix, no. 4, pp. 15, 16, 1921.

Lindsey erected this genus, with *Erycides araxes* Hewitson as the type, separating it from *Pyrrhopyge* Hubner by the different habitus and shape of the secondaries.

Genitalia. The species included with *araxes* in this paper are so placed from their general superficial appearance and the sim-

ilarity in form of the genitalia. The uncus terminates in two slightly curved and pointed arms between which there is a central projection (*araxes*) or forked with a roundish, somewhat pointed flange at the base on each side (*Maculosa, erythrosticta, cossea*). The scaphium is well developed. The girdle is rather variable in length. The aedoeagus somewhat stout, and varying in shape. The arms of the claspers are from moderate to rather long, more or less curved upward, pointed and with numerous serrations on the dorsal edge (in *maculosa* with less on the dorsal edge, and a few on the ventral edge toward the tip), and with one or two stout upward projections at the base, which are usually serrate at the tip.

A. araxes (Plate XXXIX, Fig. 51).

Hewitson, Descr. of 100 New Species of Hesp., part 1, p. 2, 1867.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, pp. 252, 253; vol. 3, pl. lxxiii, figs. 14, 15, 16 male genital., 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, pl. 162 e, 1921.

cyrillus Plotz, Stett. Ent. Zeit., vol. xl, p. 529, 1879.

Wings above brown. Primaries with a median row of three spots: a small one on the lower side of vein 2 about the center, a larger one notched on the outer edge, between veins 2 and 3, a somewhat similar one across the cell; three small, irregular spots outside of these half way to the margin, between veins 3–4, 4–5, 5–6; four subapical spots; all of the spots are white-hyaline. Beneath, brown, paler than above, fulvous in the basal area and along the coastal margin of the primaries, spots of the upper side repeated; the secondaries with a little more than the basal two-thirds fulvous, crossed by a narrow line of the ground color toward the base and a wide irregular line of similar color near the outer edge, marginal area of the wing broadly brown.

Thorax brown above, fulvous beneath; abdomen brown, the segments edged with fulvous. Head brown and fulvous intermixed. Palpi, collar and pectus fulvous.

Shoulder-covers brown mixed with fulvous. Tegulæ and anus brown. Fringes white, darkened at the apex of the primaries and intersected with brown at the vein ends.

Distribution. Type locality: Mexico. Oaxaca (*cyrillus*). Honduras (B).

A. araxes race arizonæ.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, p. 253, 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Skinner, Trans. Amer. Ent. Soc., vol. xxxvii, no. 3, pp. 201, 202, pl. x, 1911.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, 1921.

Skinner & Williams, Trans. Amer. Ent. Soc., vol. xlviii, p. 111, p. 110, fig. 1, genitalia, 1922.

Arizonæ is a northern race differing from typical *araxes* principally in that the fulvous area of the secondaries beneath is diffused and not sharply defined on its outer border and is sometimes of greater extent so that the marginal brown band is narrower. The genitalia agree with typical *araxes*.

Distribution. Type locality: "Neighborhood of Fort Grant," Paradise, Arizona, May to Sept.; Marfa, Texas (B).
Huachuca Mts., July; Baboquivari Mts., July; Cochise County, July, August; Prescott, August; all Arizona (A.M.)

A. maculosa (Plate XXXIX, Fig. 52).

Hewitson, Trans. Ent. Soc., London, third series, vol. 2, p. 485, 1866.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, p. 252, 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, pl. 162 e, 1921.

agathon Felder, Reise Novar., Lep., vol. 2, p. 506, pl. 70, figs. 2, 3, 1866.

Wings black above, primaries with nine to eleven white-hyaline spots: an oblique row of three, one in the cell, one between veins 2 and 3, a smaller one just under vein 2; one outside of these between veins 3 and 4; another toward the margin between veins 4 and 5; a smaller one obliquely above this between veins 5 and 6 (sometimes absent); four sub-apical, and sometimes another very minute one just below vein 6. Beneath the wings are black, the primaries with the spots of the upper side repeated and a basal orange area; approximately the basal half of the secondaries is orange. Fringes of the primaries black with a little white at the base between veins 1 and 3; of the secondaries white intersected with black at the vein ends. Body black above, beneath orange and black. Head black with several white dots. Palpi black with a large white spot in front and a small one below it. A large white spot on each side below the eyes. Pectus orange interiorly bordered with black. Collar black with a small white dot one each side. Shoulder-covers black. Tegulæ black with a minute orange dot near the base. Anal extremity black. Legs blackish-brown haired with orange.

Distribution. Type locality: "Bogota." Nova Granada: Bogota (*agathon*).
Colombia (B).

A. erythrosticta (Plate XXXIX, Fig. 53).

Godman & Salvin, Proc. Zool. Soc., London, p. 153, 1879.

Godman & Salvin, Biol. Centr.-Amer., Rhopal., vol. 2, p. 252; vol. 3, pl. lxxiii, fig. 13 genitalia, 1893.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, pl. 162 e, 1921.

This species is superficially very much like *maculosa* Hewitson. It differs in being slightly paler in ground color, the orange basal area of the secondaries broader, so that the dark border of the wings is narrower; in having a red spot on the upper side of the primaries (sometimes absent) toward the base of the interspace

between veins 1 and 2. All of the specimens at hand have nine white hyaline spots on the primaries except one, which has nine on one wing and ten on the other; these spots are placed the same as in *maculosa.* There is a specimen at hand from Ft. Sherman, Canal Zone, Panama, without the orange spot of the primaries which does not differ essentially in the form of the genitalia from another specimen from Chiriqui, Panama, which has the orange spot. The Ft. Sherman specimen does differ from typical *maculosa* in having the wider orange basal area of the secondaries beneath. There is some asymmetry in the claspers of the specimen from which the accompanying figure was made, the left clasper lacking the angular projection just behind the apex on the dorsal side. In another individual both claspers terminate in a very sharp point. None of those examined exactly agree with the "Biologia" figure in having the lateral plate or flange extended beyond the dorsal margin or in having the stout projection of the dorsal side extended so far upward, but as there seems to be more or less variation among individuals, in the degree in which these parts are produced, this cannot be considered of any specific significance. The species is very closely related to *maculosa.*

Distribution. Type locality: "Chontales, Nicaragua; Veragua."
Guatemala; Nicaraugua; Panama (G. & S.).
Truxillo Dist., Honduras; Ft. Sherman, Barro Colorado Island, Canal Zone, Panama (A.M.).
Chiriqui, Panama (B).

A. cossea (Plate XXXIX, Fig. 54).

Druce, Cist. Ent., vol. I, p. 362, 1875.

Mabille & Boullet, Ann. des Sciences Nat., Paris, 9th series, pp. 176, 181, 1908.

Draudt, Seitz, Macrolep. of the World, vol. 5, p. 839, 1921.

Somewhat similar in appearance to *maculosa* Hewitson but differs on the upper side of the secondaries in having a broad, curved, orange band in the center of the wing from the coastal vein to the abdominal fold; and on the under side in having the

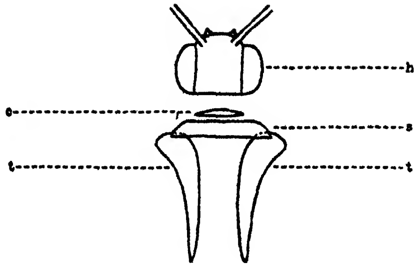
orange basal area of the primaries reduced, that of the secondaries wider as in *erythrosticta* and somewhat darker in color and crossed near the base by a narrow band of spots of the ground color. In the specimen at hand there are nine white-hyaline spots on the primaries. There is some asymmetry in the claspers, the figure here given is that of the right clasper.

Distribution. Type locality: Colombia. Colombia (B).

PLATE XXXIV

Figure A
- c collar.
- h head.
- s shoulder-covers.
- t tegula.

Figure B
- a aedoeagus.
- c clasper.
- f flange.
- g girdle.
- sa saccus.
- sc scaphium.
- u uncus.



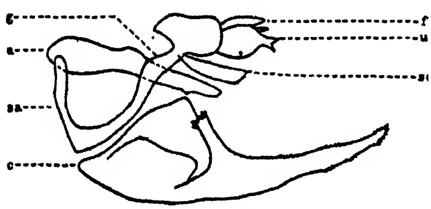
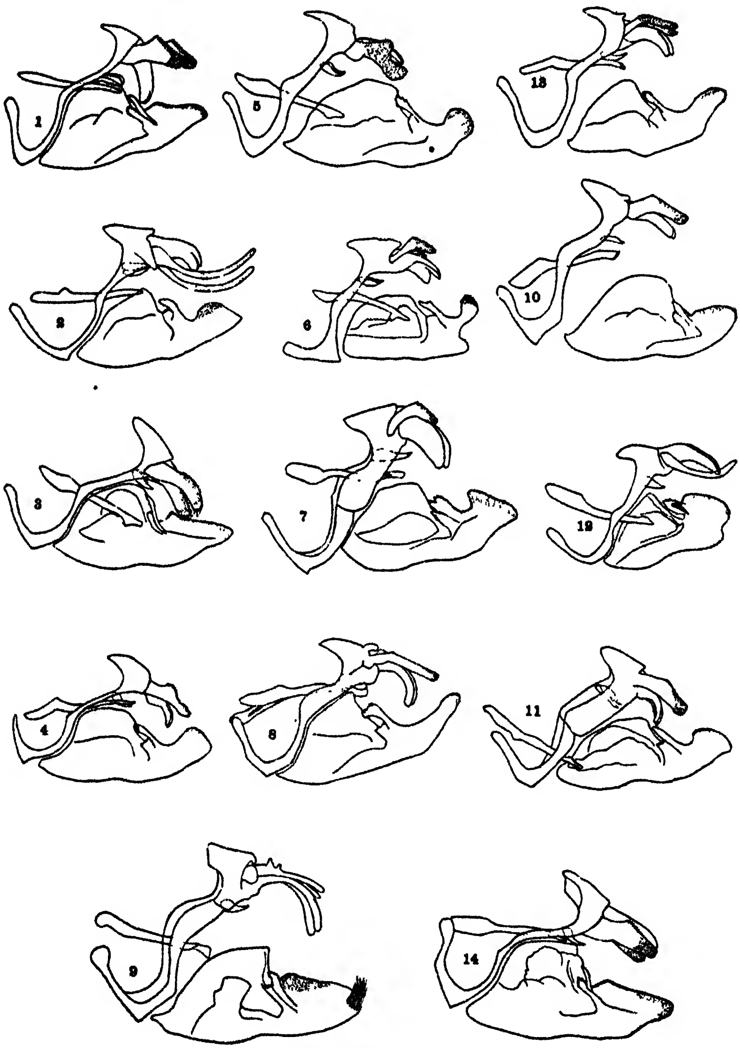


Fig. 2.

HESPERIIDÆ

PLATE XXXV

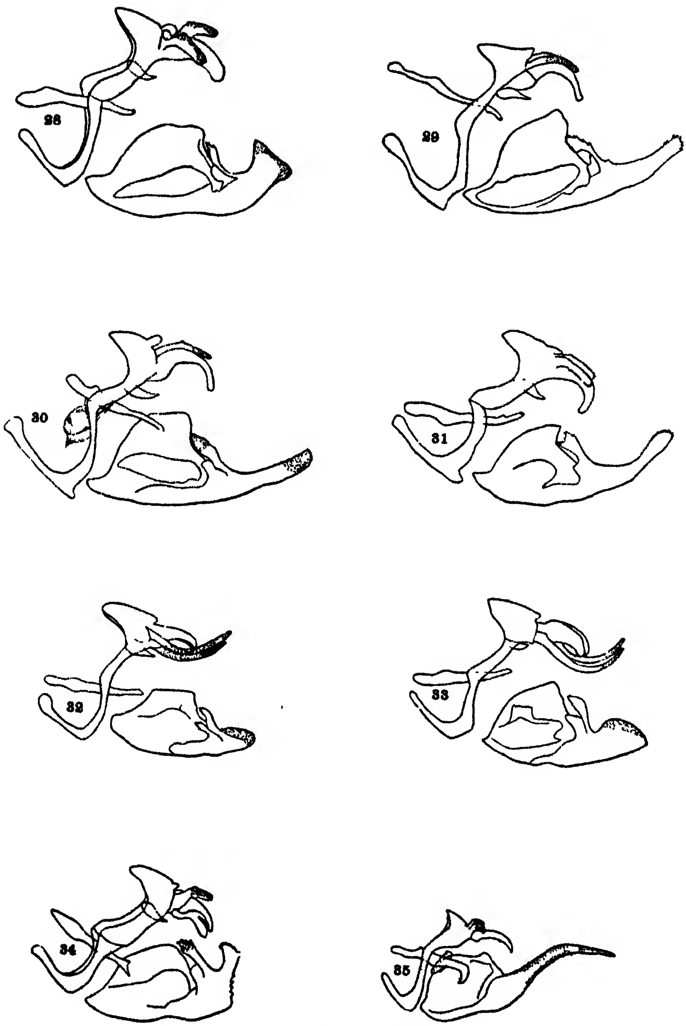
Figure 1. *Pyrrhopyge hyperici* Hubner.
Figure 2. *Pyrrhopyge sergius* Hopffer.
Figure 3. *Pyrrhopyge leucoloma* Erschoff.
Figure 4. *Pyrrhopyge araethyrea* Hewitson.
Figure 5. *Pyrrhopyge aziza* Hewitson.
Figure 6. *Pyrrhopyge papius* Hopffer.
Figure 7. *Pyrrhopyge decipiens* Mabille.
Figure 8. *Pyrrhopyge tarapotoensis* new species.
Figure 9. *Pyrrhopyge charybdis* Hewitson.
Figure 10. *Pyrrhopyge zenodorus* Godman & Salvin.
Figure 11. *Pyrrhopyge attis* new species.
Figure 12. *Pyrrhopyge rileyi* new species.
Figure 13. *Pyrrhopyge amythaon* new species.
Figure 14. *Pyrrhopyge williamsi* new species.



HESPERIIDÆ

PLATE XXXVII

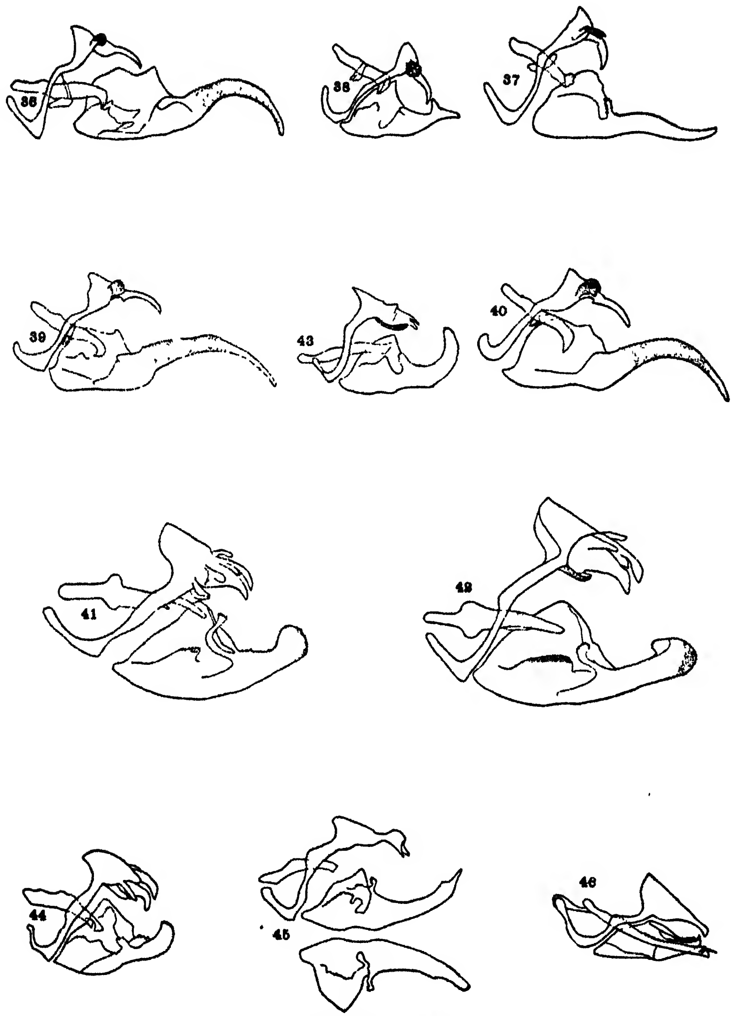
Figure 28. *Pyrrhopyge olivacea* Rober.
Figure 29. *Pyrrhopyge rubricor* Mabille & Boullet.
Figure 30. *Pyrrhopyge hadassa* Hewitson.
Figure 31. *Pyrrhopyge hades* Mabille.
Figure 32. *Pyrrhopyge amyclas* Cramer.
Figure 33. *Pyrrhopyge phylleia* Hewitson.
Figure 34. *Pyrrhopyge kelita* Hewitson.
Figure 35. *Pyrrhopyge scylla* Menetries.



HESPERIIDÆ

PLATE XXXVIII

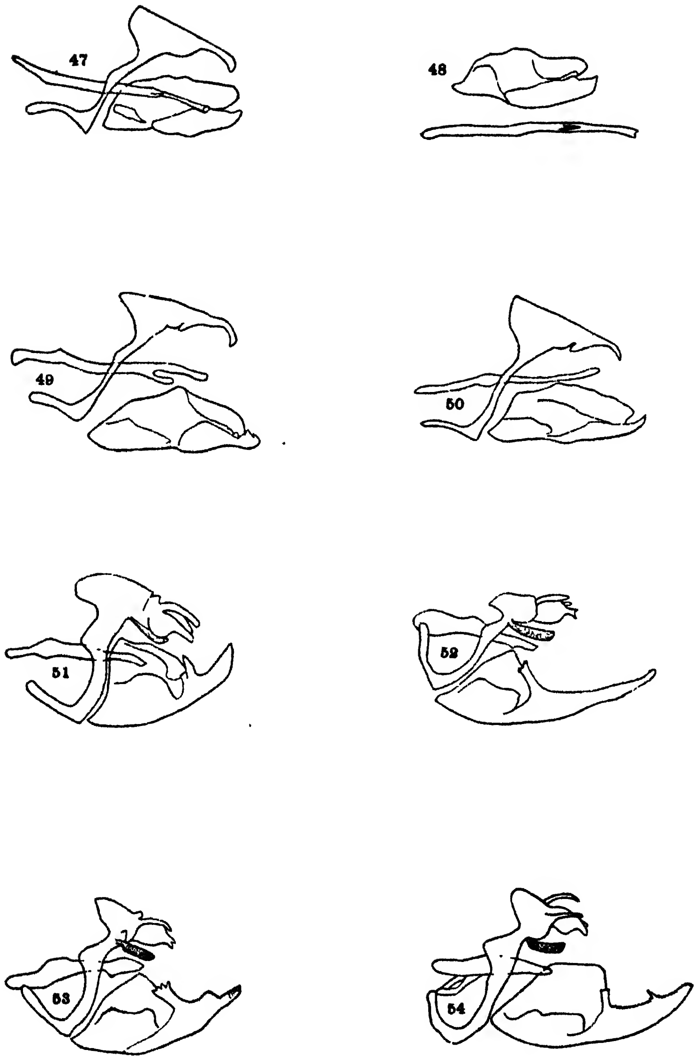
Figure 36. *Pyrrhopyge menecrates* Mabille.
Figure 37. *Pyrrhopyge adonis* new species.
Figure 38. *Pyrrhopyge mariae* new species.
Figure 39. *Pyrrhopyge fluminis* Butler.
Figure 40. *Pyrrhopyge carriae* new species.
Figure 41. *Pyrrhopyge rufipectus* Godman & Salvin.
Figure 42. *Pyrrhopyge apollo* Rober.
Figure 43. *Pyrrhopyge aesculapus* Stauginger.
Figure 44. *Pyrrhopyge chalybea* Scudder.
Figure 45. *pyrrhopyge creon* Druce.
Figure 46. *Pyrrhopyge agenoria* Hewitson.



HESPERIIDÆ

PLATE XXXIX

Figure 47. *Pyrrhopyge styx* Moschler.
Figure 48. *Pyrrhopyge passova* Hewitson.
Figure 49. *Pyrrhopyge ganymedes* new species.
Figure 50. *Pyrrhopyge fleximargo* Mabille & Boullet.
Figure 51. *Apyrrothrix araxes* Hewitson.
Figure 52. *Apyrrothrix maculosa* Hewitson.
Figure 53. *Apyrrothrix erythrosticta* Godman & Salvin.
Figure 54. *Apyrrothrix cossea* Druce.



HESPERIIDÆ

PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

MEETING OF NOVEMBER 18, 1930

A regular meeting of the New York Entomological Society was held at 8 P. M., on November 18, 1930, in the American Museum of Natural History; President Wm. T. Davis in the chair, with fifteen members and eleven visitors present.

Mr. Mutchler exhibited the sumptuous publication of the researches of Mr. Snodgrass; Mr. Davis read a review of the same from the *Boston Herald*.

The president announced with regret the approaching departure, on December 1, of Mr. Harry G. Barber for Washington, D. C., where he will study the Hemiptera of the U. S. National Museum. His private address will be 2222 Q St.

Jumping Beans used in a game, and sent from Germany by Mr. Sherman, were exhibited.

Mr. Bromley read a paper on "Hornet Habits" and exhibited specimens of the local species, *Vespa crabro*, *V. maculata*, *V. maculifrons*, *V. erinacea*, and some other species, including those from the southern and western states, with an interesting discussion of their nest-making, feeding and other habits.

His remarks were discussed by Messrs. Bird, Davis and Lacy.

Mr. Wm. T. Davis called attention to the fact that migrating dragonflies take great hazards and sometimes come north too early in the spring. He mentioned the early appearance of *Anax junius* on Staten Island on March 30, 1930, following a period of warm weather which in turn was followed by very cold weather. He also stated that on May 27, 1930, about 10 A. M., an *Epiæschna heros* was seen hawking up and down Stuyvesant Place, St. George, Staten Island. It was so cold at the time that he was surprised to see the dragonfly so active. On the morning of May 28 a male *heros*, likely the same individual seen on the previous day, was found lying on its back and in a dying condition, on the piazza of 146 Stuyvesant Place. It was still very cold when the dragonfly was found. The specimen was exhibited. On May 11, 1919, a female *heros*, that had died, was found on Staten Island.

Mr. Davis also showed some *Lasius claviger* ants that were found to be swarming on November 14, 1930, in the garden of 146 Stuyvesant Place, Staten Island. On November 6, ice to the thickness of ⅜ of an inch had formed in a pail of water within ten feet of where the ants swarmed on the 14th, a much milder day with a temperature of 57 degrees at the time the ants were observed. This species of ants was found swarming on the Island on November 7, 1922, and individual females were found walking on the

sidewalks of Tompkinsville in January and February, 1919. At the time the *Lasius* ants swarmed on November 14, a worker of *Prenolepis imparis* Say was observed snooping about near the nest as if interested in the proceedings.

MEETING OF DECEMBER 2, 1930

A regular meeting of the New York Entomological Society was held at 8 P. M., on December 2, 1930, in the American Museum of Natural History; President Wm. T. Davis in the chair, with sixten members and five visitors present.

Mr. Carl T. Parsons, Rye, N. Y., and Mrs. Alan Sloan Nicolay, 11 Seymour St., Montclair, New Jersey, were elected members of the Society.

Mr. Leng exhibited "Manual of the Genera of Beetles of America, north of Mexico," by Dr. J. Chester Bradley, of Cornell University.

Mr. Mutchler read a letter from Dr. Lutz, with greetings also from Messrs. Schwarz and Huntington, his companions at Barro Colorado.

Mr. Nicolay made an address on "Beetling at Greenville, Maine, and Difficulties of Classifying Carabidæ," illustrated by specimens and photographs and punctuated by humorous remarks. His headquarters at Greenville had been at Squaw Mountain Inn where considerable comfort was found within easy reach of a forest extending to the Canadian border. A clearing about an abandoned saw mill proved to be a locality for *Cicindela longilabris*, a brook near the fish hatchery yielding *Bembidion chalceum*, and sphagnum swamps producing interesting species of *Loricera* and *Elaphrus*. Mrs. Nicolay was fortunate in securing one specimen of *Cicindela harrisi*, and the dead hemlocks were attractive to several species of *Chrysobothris*. Commenting on local collecting during the past summer. Mr. Nicolay recorded finding *Cicindela patruela* at Mt. Pocono, and his dissent from Dr. Walther Horn's placing it as a variety of *sex-guttata*; also the discovery of a new locality for *Cicindela marginipennis* on an island in the Delaware River near Milford, Pennsylvania, where on July 4 it was abundant on a pebbly beach. He had found at Jones Beach, on Long Island, a maritime collecting ground where *Cicindela dorsalis* was common at the middle of July and where *Dyschirius*, *Omophron*, etc., occurred.

Mr. Nicolay ended his address with praise for the care with which the collection of the late Thomas L. Casey has been housed in the U. S. National Museum, whereby his types are readily compared; and the difficulties that result from alterations made in some other collections which have not been similarly treated. Some instances of this character were given.

Mr. Nicolay's remarks were discussed by Messrs. Hall, Angell and Mutchler.

Mr. Curran propounded an entomological conundrum, in describing from a letter received, an insect flying with something resembling a straw attached which it deposited in the water. It was supposed to be a May-fly ovipositing.

Mr. Wm. T. Davis, referring to his statement at the November meeting relative to the late swarming habit of the ant *Lasius claviger*, stated that on November 22, a rather warm day for the season, that the *claviger* ants at 146 Stuyvesant Place, had again swarmed. So far this is the latest date for their swarming on Staten Island. Some of the ants collected on November 22 were shown. He also exhibited some blackberry leaves that had been attacked by the common Orange-rust (*Gymnoconia interstitialis*). The leaves of the blackberry were collected in June and placed between the leaves of a book, where subsequently by reason of the rust they became very attractive to some *Dermestid* larvæ.

MEETING OF DECEMBER 16, 1930

A regular meeting of the New York Entomological Society was held at 8 P. M., on December 16, 1930, in the American Museum of Natural History; President William T. Davis in the chair, with thirteen members and five guests present.

In the absence of Mr. Leng, Mr. Bromley acted as secretary.

The following were appointed by the chair as members of the nominating committee: Dr. Lutz, *chairman*; Mr. Huntington, and Mr. Curran.

Mr. Bell related the experience of Mrs. Bell and himself during their trip to the West in May, June and July of this year. For several weeks they made their headquarters at the ranch of Mr. A. R. Wainscott about seven miles east of Fallon, Nevada. This state, while sixth among the states in area, is very sparsely populated, for the most part it lies on the Great Intermountain Plateau, with an elevation of from 4,000 to 8,000 feet above sea-level, with some of the mountains exceeding 10,000 feet elevation. Between the mountain ranges are broad, flat valleys which present desert conditions. It is a region of very little rain, but the soil is very fertile and bountiful crops can be raised when water is available. The ranch where they stayed is in the Carson-Truckee Irrigation Project and the principal crop of this and the surrounding ranches is alfalfa, which grows luxuriantly, usually three and sometimes four cuttings a year being made; grain is also raised and there are large herds of cattle, sheep and horses; there are also large rabbit farms where thousands of these animals are raised, principally for western markets. The elevation in this region is about 4,000 feet and the air is very clear and dry; the days quite warm and the nights delightfully cool. On account of the dryness of the air, one could collect in the desert without discomfort, even though the temperature was high, as perspiration evaporated so quickly that one's clothes were always dry.

The scenery was beautiful, as on all sides there are mountains, though some of them were far away. The dry clear air made them appear much closer; the high, snow-capped Sierras near Reno, 75 miles away, seemed much nearer, and the Silver Range about twenty miles to the east, continually changed color as the angle of light varied; to the north the Blue Mountains were colored as their name indicates, and to the south Mt. Grant

reared a great snow-capped dome that glistened in the sunlight like a giant iceberg.

The region is treeless, except for the cottonwood and a few elms, Chinese and Carolina poplars brought to the ranches, and in the ravines in the mountains and foot-hills, junipers and pinyons; the higher elevations have coniferous forests, but there were none in this vicinity.

There was considerable desert flora, the principal bushes being grease-wood, rabbit-brush and sage, with a multitude of small flowering plants and cacti, which transformed the desert into a beautiful garden of brilliant colors when they bloomed in great profusion during the latter part of May and most of June. There are also large and small alkaline flats on which little or nothing grows and which look like snow-covered fields.

The smaller animal life was very numerous in the Irrigation District and along the border of the desert, jack and cotton-tail rabbits abounded; the beautiful California quail were very tame, coming into the door-yard to feed and calling from the fence-posts about the ranch; Chinese pheasants were often seen along the roadside and in the garden and continually crowed from the alfalfa fields where they nest; wild ducks of several species teemed in the alkali ponds and irrigation ditches; great white pelicans frequented the ditches or flew in long wavy lines across the desert; the stately and handsome avocet waded in the shallow water in the salt marsh regions and many of them were observed lying dead along the borders of the shallow ponds, perhaps poisoned by the excessive alkaline content of these waters. There were also a great many other birds too numerous to mention in detail. The desert teemed with lizards of many species, but few snakes and these of non-poisonous species. Of the larger animals, deer are found in the wooded ravines and canyons of the mountains, on the high mesas wild horses still exist in reduced numbers and coyotes are still to be found in parts of the desert.

A mile below the ranch is the Piute Indian Reservation; the Indians have pretty much accustomed themselves to the white man's ways and have engaged in agriculture, stock-raising and other pursuits.

Among the many interesting things to be seen in this region he mentioned Walker Lake, about fifty miles to the south, about thirty miles in length and teeming with fish; the lake lies between two ranges of low mountains, along those on the west side runs the state highway, built along their slope and following their contour; many of the lower hills on the other side of the lake are slashed with bright colors as though painted by some prehistoric artist with a giant paint brush. Large caves in the foot-hills of the Silver Range which harbor a horde of long-eared bats. The Lahontan Dam which supplies the water for the Irrigation District and the great lake which it forms by damming the Carson River and which is further fed by a canal from the Truckee River. The great salt deposit covering 1,100 acres into which borings ninety feet down have not reached the bottom, and where the salt is removed with dredges it immediately fills up again, so

that despite the large quantities removed, there is apparently just as much salt left as there was in the beginning. In the desert the evidence of volcanic activity of the past ages, and the relics of Indian life of long ago.

Although insect life abounded in both the Irrigation District and the desert and considerable material in various orders was collected, there were very few species of *Hesperiidæ*, which were his especial quest, only five species being taken; on the more interesting of these he expects to later publish some notes.

After leaving the desert region, Mrs. Bell and he spent a short time at Lake Tahoe, California, a well-known region of great scenic beauty, and from there travelled by auto and mail-stage down the eastern border of California, stopping at Mono Lake and other points, where they did some further collecting. They spent several days in Los Angeles where they visited the principal points of interest in company with Mr. and Mrs. J. D. Gunder, of Pasadena; these included the Los Angeles Museum, meeting Dr. J. A. Comstock and other members of the staff; among the numerous exhibits of this fine museum especially noteworthy were the very fine groups of African animals, and the great collection of skeletons, in perfect condition, of prehistoric animals taken from the asphalt beds in California. They also visited Mr. and Mrs. Hal Newcomb, the well-known dealer in insects, of Pasadena; and one day was spent in a visit to Catalina Island.

Mr. Bell showed an excellent series of photographs illustrating the type of country in the various parts of Nevada and California that he visited and also showed the members a collection of *Hesperidæ* collected in this region. He further showed some Indian arrow-heads as well as some strikingly marked stones from the desert, one of which closely resembled the huge canine tooth of a carnivore.

Mr. Davis then showed the Society some samples of Orthoptera and Odonata collected by Mr. Bell and commented on the resemblance of *Libellula forensis* to the common *L. pulchella* of the East. Mr. Davis remarked that certain predaceous insects range across the continent, in contrast to many herbivorous insects like the cicads, which do not have such an extensive range.

Mr. Davis also exhibited a series of cicadas collected by Mr. Bell and commented on the long-continued song of the *Okanoganas*, common in Nevada in contrast to the shorter songs of the species of *Tibicen*, common in the East. He then exhibited a series of cicadas of the genus *Tibicen* collected on sidewalks in Flushing, L. I., including *linnei*, *canicularis* and *chloromera*.

Mr. Lacy then spoke on the variations of the butterfly *Colias eurytheme* and exhibited an extensive collection of the summer form taken by him this season. He noted that the variations were most marked in the female.

Mr. Lacy also showed a cerambycid beetle from Colorado, *Typocerus sinuata*, which was reported as producing sound by the movement of the thorax against the abdomen.

Mr. Curran exhibited some *heliconias* from Panama, which showed some remarkable resemblances between species in the same genus. This was the more remarkable as the two species resembling each other belong to different divisions of the genus as evidenced by the difference in the genitalia.

Dr. Bequaert showed the Society two specimens from Yucatan, which served as a remarkable instance of Tautopsis. One specimen was a large green cyrtid fly (*Lasia* n. sp.) and the other a green bee (*Euglossa cordata*). Dr. Bequaert stated that not until he had actually removed the insect from the net, did he perceive that it was a fly and not a bee as first thought, the resemblance being so marked.

Mr. Mutchler showed the Society a copy of Dr. L. O. Howard's recent work on the "History of Applied Entomology" in which the members evidenced a great deal of interest.

Mr. Bromley exhibited a lucanid and several histerids, the latter taken from a dead water moccasin in Lake Worth, Florida, and declared by Mr. Ballou to be extreme southern records for the species concerned.

Mr. Davis commented on the passing of Dr. Emerton and spoke of his work on spiders and his varied interests. Mr. Bell read a paper on some interesting phases of natural history in Jamaica, by Miss Perkins of that Island.

MEETING OF JANUARY 6, 1931

A regular meeting of the New York Entomological Society was held at 8 P. M., on January 6, 1931, in the American Museum of Natural History; President Wm. T. Davis in the chair, with eighteen members and eleven visitors present.

The report of the nominating committee was received and, there being no other nominations, their nominees were elected by an affirmative ballot cast by Mr. Davis, as follows:

President, Andrew J. Mutchler.
Vice-President, E. L. Bell.
Secretary, Miss Elizabeth Sherman.
Treasurer, Gaylord C. Hall.
Librarian, Frank E. Watson.
Curator, A. J. Mutchler.
Executive Committee, Wm. T. Davis, Wm. Moore, Herbert F. Schwarz, Howard Notman, Henry Bird.
Publication Committee, Harry B. Weiss, Chas. Leng, John D. Sherman, Jr., C. E. Olsen.

FRANK E. LUTZ,
C. H. CURRAN,
E. I. HUNTINGTON,
Nominating Committee.

Mr. Mutchler, having assumed the chair, called upon Mr. E. I. Huntington for his paper on "Collecting Rambles in Panama," with illustration

by lantern slides. Mr. Huntington had, in company with Dr. Lutz and Mr. Schwarz, spent the time between November 5 and December 5 at Barro Colorado Island with visits also to Summit, the Chiva Chiva Trail, Corozal and Paitilla Point. He described the laboratory and other buildings and features of the Island, showing many illustrations thereof, and spoke in a general way of the mammals, birds and insects. For a more complete account he referred his hearers to Dr. Frank M. Chapman's book, "My Tropical Air Castle."

Of particular interest was his account of the collections made by Dr. Lutz of the Army Ant and his queen of which a specimen was shown. Dr. Lutz added a little on this subject, pointing out that the severity of the bite the Army Ant inflicts had been somewhat exaggerated.

Mr. Leng exhibited Dr. J. Chester Bradley's "Manual of the Genera of Beetles of America, north of Nexico," a remarkably successful attempt to bring within a single volume the characters of all the genera by means of dichotomous keys. For the first time since the publication of the Leconte Classification these characters are thus made available to students.

Mr. Curran added that the key to the families was already required to be reprinted.

Mr. Davis, recalling his previous remarks on *Lasius claviger* swarming on November 22, added that he had seen one walking, very timidly, on the snow on January 2. He exhibited the "Life of Thomas Say" by Harry B. Weiss, with praise, commenting on the election of Mrs. Say as an honorary member of the Natural Science Association of Staten Island, and on Dr. Howard's remarks anent the father of Say, although a prominent merchant of Philadelphia, now being remembered for the fame attained by his son.

Mr. Davis also exhibited the minute book of the Entomological Club of New York, written by Henry Edwards in 1881, and recording among other items the election of himself, then a boy of 16, as a member on nomination by Mr. August R. Grote. He added some recollections of Mr. Grote's residence on Staten Island and subsequent life in Germany.

The minutes of the club disclosed many items of interest in connection with Neumogen, Elliott, Halset, Snow, and the publication of "Papilio."

Mr. Curran, supplementing the remarks of Mr. Davis, described Prof. Snow's escape from Apache Indians with his butterfly net as evidence of mental weakness.

MEETING OF JANUARY 20, 1931

A regular meeting of the New York Entomological Society was held at 8 P. M. on January 20, 1931, in the American Museum of Natural History; President Andrew J. Mutchler in the chair, with eighteen members and eight visitors present.

The minutes of the preceding meeting were read and approved.

The president announced the appointment of committees, etc., as follows:

Auditing Committee—E. L. Bell, Dr. E. K. Schwarz, Dr. E. H. Janvier.

Field Committee—Mr. and Mrs. Nicolay.

Program Committee—C. H. Curran, H. B. Weiss, Dr. J. L. Horsfall.

Delegate to the N. Y. Acad. of Sci.—Wm. T. Davis.

Mr. J. W. Wilson, of Pierson, Florida, was elected a member.

Mr. Davis exhibited Proc. of the Junior Soc. of Nat. Hist. of Cincinnati, Ralph Dury, secretary, and commented upon the article therein by Charles Dury, who was 83 years old on Nov. 14, 1930.

He also showed "A Contribution to the Knowledge of Florida Odonata" by Dr. C. Francis Byers, published as number 1 of University of Florida Publications, and a further article by the same author in the *Florida Naturalist.*

Dr. Leonard spoke with lantern slide illustrations on "Entomology in Porto Rico." He described the Federal Experiment Station at Mayuguez established in 1900, and the Insular Experiment Station at Rio Piedras established in 1910, and of the good work done by Tower, Wolcott, Dozier Smyth, Sein, Danforth and others at these institutions. In addition he mentioned Garcia and Dexter at the University, Mills of the Federal Plant Quarantine, Hoffmann at the School of Tropical Medicine, and Kramer of the Forest Service as contributing, also Osborn working for Sugar Centrals. He spoke of the principal economic problems being studied, insects affecting sugar, tobacco, coffee, citrus fruits, pineapples, cotton and vegetable crops.

His remarks were discussed by Mr. Curran who exhibited the Mss. of his second paper on Porto Rican Diptera, by Mr. Davis who exhibited a box of Cicadidæ, containing the two species known from Porto Rico, by Mr. Leng who described the work in progress on the Coleoptera and who recalled Dr. Krug's early efforts to make them known.

Dr. W. Dwight Pierce, present as a guest, spoke of his efforts to classify the exceedingly variable species of Diaprepes.

Mr. Mutchler exhibited four boxes of Porto Rican longhorns and speaking of them, the Elateridæ, and other families thus far studied, stated the number of species now known to occur as about 740.

Dr. Leonard in reply to questions said that, while the climate was suitable for banana growing, it was not a commercial proposition. The root weevil was all over the island in the trees grown by the natives, and no control measures were used by them.

MEETING OF FEBRUARY 3, 1931

A regular meeting of the New York Entomological Society was held at 8 P. M. on February 3, 1931, in the American Museum of Natural History; President Andrew J. Mutchler in the chair, with twenty-two members and fifteen visitors present.

The minutes of the preceding meeting were read and approved.

Mr. Hall's report as treasurer, audited by Mr. Bell, was received and accepted with thanks.

Dr. Alfred Weed, Charles Egri, and Dr. Creighton were proposed for membership.

Dr. D. Dwight Pierce spoke on the "Insect Problems in the Philippines." He was ordered to the Philippines in the summer of 1927 by the Honolulu Trust Co., and was employed by the Victoria Milling Co. and the North Negros Sugar Co., in the study of sugar cane insects. He spoke of the cordial reception given him by the Entomological Society of Honolulu, of the work of Dr. Carl F. Baker, Dr. Chas. S. Banks, whose interest in the silk worm has led him to the development of a new strain which is disease proof, and of Dr. L. B. Uichanco and Otanes, the two official entomologists in the Philippine Archipelago, also of Dr. A. W. Lopez, the entomologist of the Philippine Sugar Association.

Dr. Pierce told of his furnished house, which was ready for him when he arrived, under which he had his laboratory, with its water table to afford isolation in breeding. In regard to the climate, his tests showed the very small range in temperature and humidity, the excessive rainfall, ten days being the longest period known without rainfall, and the importance of wind for comfort. His territory was the northwest corner of the island of Negros, comprising 200 or 300 haciendas or plantations, which yield an all-year-round harvest, except for September and October, when the mills and equipment are reconditioned.

Dr. Pierce's chief problems in the laboratory were: the training of his assistants (natives), and a continual struggle with ants, fungi, mites, moisture in the glass tubes and also rodents; mold was avoided by lights in the cabinets. In the field he found that the greatest damage was being done to the cane by the dead heart moth borer, Olethreutes, and by fly borers. With great difficulty he located an egg parasite, individuals of which he planted in groups of 10, then 25, 50 and finally 100 as nuclei in each hacienda. These reduced the damage being done to the cane from 30 to 2 per cent., in a little over a year, by never letting the parasitism fall below 70 per cent. Dr. Pierce then spoke of the cultural system he had found necessary, viz.: the burning of stalks and all trash, seed selection, soil nourishment and rectification, and close cutting of the stalks. His parasite theory is that of redistribution of the parasites. He said it was found impractical to use chemicals as they poisoned the many weeds and plants which were food for the natives. The superstitions of the natives, who were his helpers, were a great hindrance to him, as was their belief in fairies, one of which was the queen termite found in all termite mounds, and also their faith in witch doctors. Dr. Pierce then explained the importance of the plant complex, the bearing that every plant has on sugar cane.

In answer to Dr. Pierce's remarks on the edibility of grubs, snails, bamboo, etc., Mr. Curran mentioned the fact that the swarms of locusts in the Far East are often used as food by the natives.

Dr. Pierce said that he wished to present his list of "Insects, Their Injuries and Their Parasites" which he found in Negros, a list which con-

tains more species than has been listed from any other one island, such as Cuba, Java, or Hawaii.

Dr. Felt mentioned the possibility of control by modifying the environment.

Dr. Pierce said that a happy medium of temperature, humidity, pressure and light was necessary and described his efforts to rid a garden in California of snails and slugs, without using arsenic or bran bait. He found that Ferris sulphate produced an electrical reaction when the slug came into contact with it which killed the slug; also this chemical killed the worms in dogs and goats, and was beneficial to the soil.

Mr. Ballou mentioned table salt as an effective killer of slugs.

Mr. Curran read a communication from S. W. Bromley in Columbus, Ohio.

President Mutchler exhibited a new publication of the Biological Monographs and Manual, "Migration of Butterflies," by C. V. Williams.

Mr. Sherman said that it had been reviewed in "Science" by L. O. Howard.

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OF THE

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Vol. XXXIX December, 1931 No. 4

THE ADDITION OF A NEW SKIPPER, ADOPAEA LINEOLA (OCHS.), TO THE LIST OF U. S. LEPIDOPTERA

By G. W. Rawson

Detroit, Michigan

Since 1910 an introduced species of European skipper, *Adopaea lineola* (Ochs.), has been reported in the province of Ontario, Canada, but there has been no recorded instance as yet of its appearance within the borders of the United States.

In 1927 and each year following, the writer has been taking specimens of a bright golden brown skipper near Detroit, Michigan, which were not identified until quite recently. With the assistance of Professor W. T. M. Forbes, of the New York State College, and Mr. Sherman Moore, of Detroit, these specimens have been identified as *Adopaea lineola* (Ochs.), thus establishing what appears to be the first record of the occurrence and colonization of this insect within the territory of the United States.

It is interesting to note that the distance from London, Ontario (where *Adopaea lineola* was first reported), to the locality in Michigan where it is now found is approximately 120 miles. If we were to judge the migration of this skipper in mathematical terms, its arrival in the neighborhood of Detroit would represent an advance of about seven miles a year. So far, *lineola* appears to be confined, in the United States, to the southwestern

shore of Lake St. Clair. No local collectors have reported taking *lineola* west of Wayne County, Michigan. How far north or south of this locality it may occur has yet to be determined. In 1927 the writer took one specimen (♀) at Findlay, Ohio. It is therefore possible that colonies have established themselves in Ohio as well as in Michigan. It is requested that lepidopterists be on the lookout for this skipper, particularly those who reside or expect to collect in the States bordering Lakes Huron, St. Clair and Erie. If any one should find *lineola*, will they please report its occurrence, together with the date and locality, to Mr. Ernest L. Bell, 438 Amity Street, Flushing, L. I., New York. Here we have an opportunity to trace the spread of a new species of butterfly and to study the various factors which may influence its distribution. If any collector is doubtful as to the identity of specimens, Mr. Bell or the writer will be only too glad to offer assistance.

Adopaea lineola is a rather pretty skipper, the upper surface of the wings in both males and females being of a golden brown color. The submarginal border of both the fore and hind wings has a black band about one-half to three-quarters of a millimeter in width. From this radiates a grayish yellow marginal fringe of scales about the same width as the black submarginal band. The veins on the upper surface of both fore and hind wings are black, and black markings, extending slightly on either side of the veins, widen as they approach the outer margin of the wings. Black stigmata are found on the fore wings of the males.

The thorax and abdomen are covered with rather short reddish or golden brown hair (or scales), while the tip of the abdomen is yellowish gray. The chitin on the thorax is black, quite noticeable on rubbed specimens but practically indistinguishable in those that have freshly emerged from the pupa. The eyes are dark brown. The antennæ are dark brown, faintly annulated with golden brown rings. The tips of the antennæ are black. The under surface of the fore wings is yellowish brown and the base black or very dark brown. The black submarginal band which has been described as occurring on the upper surface is only faintly reproduced on the under surface of the wings and

is very narrow there. The color of the under surface of the hind wings is greenish or yellowish gray. The black venation, which is quite conspicuous on the upper surface of the wings, does not occur at all on the under surface of either fore or hind wings. The costal margin on both the upper and under surface of the fore wings is black. There is no pronounced difference in markings or coloration as between the sexes; in fact, it would be difficult to tell the males from the females if it were not for the stigmata. Even these are not very well defined and one has to examine specimens rather closely to determine the sex. The wing expanse in the males is 24–26 millimeters; in the females 26–30 millimeters.

Out of about two hundred specimens of *lineola* taken last year (1930) there were two males that showed a rather marked difference in coloration. These differed from typical specimens in having the upper surface of the fore wings a golden yellow instead of the usual golden brown. The upper surface of the hind wings is much darker than in typical specimens; in fact the inner half is a dark olive brown shade. The under surface of the wings of this aberrant form is similar to typical specimens, but the color is not so dark, being of a greenish olive more than a yellowish gray. These two aberrant specimens are somewhat smaller than typical males. No atypical females have been noted so far.

The writer has not very closely studied the habits of *Adopaea lineola*. The flight is not particularly strong for a skipper, and the insect is rather easy to catch. Specimens may even be caught by placing a cyanide bottle over them. The females are quicker to take flight than the males. *Lineola* is fond of red and white clover, also milkweed. Several specimens were found (dead), caught by their legs between the clefts of the glands on the pollen masses of the milkweed flowers. Mud puddles are also frequented.

The males appear about the middle of June, and females about 7–10 days later. Few specimens remain by the end of July; such as are found after this time are usually very much battered and worn. The ratio of males to females (from limited observation) appears to be about three to one.

Adopaea lineola has been increasing rapidly in numbers in the limited area where it is to be found in Wayne County, Michigan. Last year (1930) it was so abundant as to literally swarm from the middle of June to the first of July.

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NOTES ON THE BIOLOGY AND SOCIAL LIFE OF EUPONERA GILVA ROGER VAR. HARNEDI M. R. SMITH

By Caryl Parker Haskins

Because of the great kindness of Dr. M. R. Smith in generously giving to the writer living colonies of the ant *Euponera gilva* var. *harnedi* (Ponerinæ, Ponerii) described by him in a recent number of the "Annals" of the American Entomological Society, it has been possible to subject living colonies of this highly interesting insect to daily observation for more than a year. Innumerable problems of biology and social behavior, both common to the Ponerinæ in general and peculiar to the species, still await solution, and the material which is presented here can be considered as nothing more than the result of the most superficial investigation. Nevertheless it is considered, because of the historic background of the species, its peculiar nature, and its unusual adaptability to artificial environments, that sufficient data has accumulated to be worthy of brief delineation at the present time, in the hope that it may be of some interest to those concerned with the Ponerinæ of North America.

Social Habits

The colonies of *E. harnedi*, in common with those of most other species of Ponerinæ, tend to be restricted to rather small size, but this is far less true of the present species, and perhaps of the Ponerii in general, than of several other tribes. In Mississippi, where the ant has been especially studied by Dr. Smith, from whom all information concerning the species under natural conditions has been derived, the formicaries are excavated by preference in rotten logs and stumps in woodland areas. Unquestionably the ant is very largely hypogeaic in habit, but that it is strictly so may be questioned. Under artificial conditions individuals have shown both inclination and ability to emerge from artificial earth-containing nests to forage, later returning to their formicaries through a narrow opening, which was readily

located. Provender placed at some distance was successfully secured and brought within in a short time. It is believed that under normal conditions the ants maintain a few open galleries, carefully concealed, from which they may emerge to forage along moist wood surfaces, returning in a very short time, much in the fashion that *Ponera coarctata* workers forage along moist ground. At the time of the liberation of the winged forms this tendency becomes exaggerated. In the artificial nest a crater was built about the entrance at such time, punctured throughout with galleries, and the winged forms, together with a large number of workers, massed directly beneath it for several days.

Males and perfect females are produced in Mississippi during the months of May and June, and colonies kept artificially in Connecticut and New York produced them at the same time. The males are fully pigmented when hatched, and the wings are fully expanded, though soft and not folded, on emergence from the cocoon. They are rather helpless, however, but become fully matured and active within eight hours, and show an inclination to leave the nest when about four days old. The females are hatched with soft but fully-expanded wings, the pupal skin having been shed within the cocoon, and bearing the pale lemon-yellow coloration of the callow workers. Full adult coloration was assumed in the specimens observed in from eight to twelve days.

It is believed that a true nuptial flight occurs, but this has not been observed. The winged females matured in the artificial nest showed a desire to leave within two weeks after hatching, but being accidentally prevented from so doing, cast their wings within the nest when from nineteen to twenty-seven days old, and remained with the parent colony. Almost certainly this procedure was an aberration induced by artificial conditions. It is precisely similar to the action of young females of the genera *Ponera* and *Stigmatomma,* which normally emerge, under artificial conditions. In all probability the nuptial flight of *E. harnedi* is conducted as with *Ponera* and *Stigmatomma,* where the young queens, for the most part resting on the ground or on low vegetation near the nest-entrance, are fertilized by the active, low-flying males.

No data has been obtained on the action of the young queen after fertilization. The usual presence of supernumary queens in wild colonies would indicate that as a rule the winged females return to the parent colony, which multiplies by division. These supernumary females are sometimes very plentiful. One colony generously given by Dr. Smith contained no less than ten such queens associated with some sixty workers. It was readily split, and the resulting colonies, each with a single queen, continued to develop without difficulty. It is an interesting fact that supernumary queens, if isolated from the workers about them, are often hostile, indicating the possibility that alien females may sometimes be adopted.

On the other hand, fertile females if isolated clearly show the instinct of colony foundation in the fashion employed by higher ants, and at least one female voluntarily isolated herself. In the presence of a complete lack of direct evidence, it may be tentatively considered that, while the majority of young females are fertilized near their own formicaries and return to them, a few fly actively and establish independent communities.

The relations between adults in colonies of *E. harnedi* are in general rather simple, but show certain curious complexities. Distribution of ingluvial food from worker to worker rarely takes place under normal conditions, due to the eminently entomophagous nature of the species, yet it is believed that both the instinct and the ability are present. To test this, a drop of honey was fed to a colony which for a long period had been fed only on the larvæ of higher ants. Several workers imbibed it after some hesitation, and returned to the brood chamber. Here they were beset by a cordon of sisters, actively soliciting food with the forefeet and mandibles. Most of these were ignored, but one was finally accepted. After soliciting a moment this seeker became rigid, and eagerly licked the tongue of the full-fed individual. This was continued without interruption or further solicitation for half a minute, when the solicitor broke away and hurried off at once. No drop was seen to pass between the individuals, but the impression that feeding by regurgitation actually had taken place was very strong indeed. Moreover, a young callow, two days old, was present in the

brood-chamber and solicited actively. Within an hour its crop was filled, and it is hardly likely that it would have fed of its own accord without the interior of the nest.

Deportation is practiced extensively and skillfully. Workers or perfect females are seized by the mandibles and dragged forward, their captors running backward. Old queens and callow queens and workers are deported most frequently when the nest is disturbed, but adult workers are often given similar treatment. Males are seized most frequently by the antennæ, sometimes by the lateral margins of the small head, and deported in similar fashion.

Communication of a rudimentary sort is effected readily among workers, but, as it is both less perfect than that among higher ants and has not been as carefully experimentally tested, little may be said of it. Many of the usual modes employed by higher ants are present, notably divarication of the mandibles and extensive use of the antennæ and forefeet, especially in the solicitation of nourishment. Stridulation has not been observed with sufficient certainty to be affirmed, but it is believed, for reasons later to be given, that it is used, though with less precision than among the Myrmicinæ.

The range of acceptable alimentary substances is much greater with *E. harnedi* than among many hypogeaic Ponerinæ, and the rather adaptable nature of the species is shown in the readiness with which new food sources are recognized and exploited. Meat, fruit, and honey are all readily accepted, though rarely fed to the larvæ, and a wide range insect food is taken. In the artificial nest houseflies, queens and workers of *Termes flavipes,* and larvæ and pupæ of the ants *Camponotus novaboracensis, C. americanus, Lasius americanus, Acanthomyops claviger, Formica subsericea, Cremastogaster lineolata,* and *Leptothorax longispinosus* have all sustained colonies for long periods.

The nest-form of the species is rather highly developed. Large and definite brood-chambers are maintained, smoothly finished and kept entirely distinct from the galleries, which are long and tenuous, but well-made. Compact kitchen-middens are maintained, usually near the nest-entrance, and no foreign

material is tolerated within the interior of the formicary. Unused food particles, empty cocoons, pupal excuviæ, and dead adults are brought at once to the refuse-pile and there discarded. Workers tend to die, from whatever cause, in the interior of the nest rather than outside as with *Stigmatomma pallipes,* and are dragged immediately, often before they have hardened, to the middens. If the entrance to the artificial nest be opened, the refuse is carried from the pile and cast outside within a short time.

Young queens and males, after they have matured, receive no more attention within the nest than workers, except that males receive the treatment accorded immature forms when the nest is disturbed. Fertile females are given somewhat more attention than workers, but no more than their greater size and power would warrant. When the nest is disturbed they are deported more often than workers. They move freely about the formicaries without attendants, feeding directly on food which they encounter. They participate in every function of the nest except foraging, caring for the young as competently as the workers, even in large colonies, and often assisting in excavation of galleries.

Development of Brood, Relations Between Adults and Brood

The fertility of the queens of *E. harnedi* is unusually high. A single queen, living under the handicap of artificial conditions, reared to the pupal stage seventy-six young in the course of sixteen months, and the number of eggs which were laid and devoured or which perished must have been nearly half as great. This is rather surprising in view of the fact that the eggs are unusually large relative to the parent insect. The queens measure in the neighborhood of .600 cm., while the longer axis of the egg measures not far from .125 cm. When timed in the height of the laying season, this queen was observed to lay seventeen eggs between February 28 and March 22, 1929, an average of .773 eggs per day.

Shortly after being laid, the eggs, rendered adherent by their coating of saliva, are brought together in packets of twenty or

more, and allowed to lie on the floors of the brood-chambers. It is difficult to determine accurately the lengths of incubation periods for more than a few ova unless numerous colonies are at hand, since when many eggs are present determination of the identity of any given specimen becomes practically impossible. But four determinations, therefore, have been made which are considered worthy of record. These eggs hatched respectively in 31, 30, 30, and 31 days at a mean temperature of about 23° C.

Immediately upon hatching the larva is removed from the egg-mass and allowed to lie singly on the chamber floor. Not infrequently the ova and hatched larvæ are kept in separate chambers, and a rough division of the larval brood according to size is usual, but not rigidly maintained. The larvæ are fed with bits of solid food in the usual Ponerine fashion, and are active and athletic, and wholly entomophagous. They are surprisingly sensitive. Not infrequently, when food was introduced at the entrance to an artificial nest, larvæ uncurled and stretched their long necks in search of it. It is possible that this action resulted from an association of light, perceived through the general integument, with the fact of food as previously experienced.

The adults of the colony spend much time in licking the larvæ for exudates and also apparently for saliva. This food, indeed, seems normally to constitute the entire diet of the callows for the first few days. The adults frequently pinch the larvæ vigorously about the neck and abdomen, apparently to hasten and encourage .he flow of exudates.

When mature, the larvæ are carefully covered entirely with earth in the usual manner, and spin at once. The earth is removed as soon as the first sheet of silk is completed, and the cocoon is cleaned within a short time. The entire process has been seen completed within nineteen hours. Within two days a well-defined meconium spot appears. The developmental periods observed for larvæ, from the time of hatching to the time of cocoon-spinning, were 21, 22, 25 ,33 days, varying with the temperature and particularly with the feeding. The time for the appearance of the reconium was observed as 1, 2, 2, 1, 2 days. In one case a larva not ready to spin was seen covered with earth. It was left in this condition for five days, when it

perished, and the earth was removed on the following day. It is rather doubtful whether this situation ever arises under normal conditions, but it is believed that the reverse condition, which often occurs in the artificial nest, may sometimes take place normally. This is the failure to cover larvæ ready to spin. Under artificial conditions the larvæ so treated transform to naked semipupæ and are then usually destroyed. The writer, however, has taken a perfect naked pupa from a wild colony of *Ponera coarctata*.

The cocoons of queens and males are somewhat larger than those of workers, and the latter are somewhat more baggy, at least in some cases, but it is practically impossible to distinguish the larvæ of the perfect forms, even when fully matured. The specimens observed, however, were reared in the artificial nest, and tended to nanism on this account. This may well not be true under normal conditions. The duration of the pupal stage differs little from queen to worker. The observed periods were 31, 32, 31, 31, 33, and 33 days. The period spent in the cocoon by an observed developing male was 36 days.

It is believed that the young adults of *Euponera harnedi* are able to emerge from the cocoon without assistance, but this has not been tested. A hatching cocoon is usually surrounded by a number of workers, biting and tearing at the anterior pole. The cocoon is sometimes opened by their efforts, but usually by those of the young callow. Eclosion is usually rapid, becoming complete in half an hour, but may take much more time. In one observed case nearly twelve hours was required. The entire head of the callow is eagerly licked by the attendants as soon as it appears, and often the young insect is dragged from the cocoon, laid with the ventral side up, and licked and pinched exactly as though it were a larva. Substantially the same treatment is accorded perfect females and males. For a day the young queens and workers are very helpless, and remain quietly in the brood-chamber. Thereafter they take an active part in the colony, though they usually remain in its interior for a few days. They forage, however, long before having assumed full adult coloration. The duration of the callow stage has been

observed as 14, 19, 17, 21 days for workers, and for queens, 12 and 8 days. The period at which full adult coloration is assumed is difficult to estimate with any degree of accuracy, and false estimations probably account for the irregularities of these figures. The eyes of the callow females are fully pigmented on emerging, and are conspicuous against the uniform pale yellow coloration of the body.

SIGHT

Except in the male, the sense of sight is poor with *E. harnedi*, as would be expected of a hypogeaic ant, but the eyes are far from useless. Darkened squares placed over the glass pane of the artificial nest quickly attract the ants, and the brood is shortly transferred beneath them.

Through the great kindness of Dr. Erwin Burr Kelsey and Mr. Eugene Marchand of Sterling Chemistry Laboratory, Yale University, it was possible to set up an earth-containing nest of *E. harnedi* in a darkened laboratory in the field of a solar spectrum. This spectrum was produced by the diffraction of a beam of light from a carbon arc, passed through a condensing lens and a carbon disulfide-glass prism and was so arranged that it was exactly adjustable to the size of the nest used. It was thus possible to limit the choice of the ants to the humanly visible spectrum, and eliminate an unknown but very gross error of absorption caused by the action of the absorption curves of CS_2, very steep in the ultra-violet, and of several types of glass. The nest contained two queens, twenty-five workers, and ten larvæ.

The experiment was begun at 2:30 P. M. At this time the ants were generally distributed throughout the nest. At 2:36 a concentration was apparent in the green region, which shortly shifted toward the red. One queen proceeded to the red, followed by several workers, one of which was deported by a sister. The other queen, with several workers, migrated to the extreme violet. Thereafter, at the times indicated, the concentrations were as follows:

Time	Red	Yellow	Green	Blue	Near Violet	Far Violet
3:30	1 ♀, 7 ☿	0	0	3 ☿	0	1 ♀, 11 ☿

The spectrum was suddenly reversed. There was an immediate movement from the end now violet toward that now red,

and *vice versa.* All seven workers formerly in the red started at once toward that color.

Time	Red	Yellow	Green	Blue	Near Violet	Far Violet
3:10	1 ♀, 8 ☿	0	2 ☿	4 ☿	0	1 ♀, 11 ☿
3:14	1 ♀, 7 ☿	0	0 ☿	6 ☿	0	1 ♀, 10 ☿

A larva was seen carried into the red, where most of the larvæ were collected, at 3:11. It was later returned to the green. The spectrum was again reversed. The reversal was marked by prompt and vigorous efforts of the ants to follow the change of colors, the movement being most noticeable at each end.

Time	Red	Yellow	Green	Blue	Near Violet	Far Violet
3:19	1 ♀, 9 ☿	0	0	1 ☿	1 ♀, 9 ☿	6 ☿

The spectrum was then removed and the ants left in darkness until 3:25, when the colors were again flashed on.

Time	Red	Yellow	Green	Blue	Near Violet	Far Violet
3:30	1 ♀, 4 ☿	0	1 ☿	1 ♀, 3 ☿	7 ☿	10 ☿

The queen in the blue was, when observed, being deported toward the red by one of the three workers.

It is unfortunate that in certain recordings not all the workers present could be located, because of the very dim light which could be permitted for observation without materially changing light conditions in the nest. For the same reason, it cannot be affirmed that the individuals were the same at the red and violet ends after each reversal of color, but it is certain that there was a movement tending toward that condition. Though poorly controlled and rough, it has seemed to the writer that this experiment indicated rather markedly an ability of *E. harnedi* to differentiate delicately between light intensities, if not to distinguish colors. What the relative intensities of the colors were cannot be determined, due to the irregular shape of the CS_2 prism and ignorance of the absorption-curves of the arc-lamp lens.

To eliminate the physical factor of differing light intensities, resort was had to the Wratten color filters manufactured by the Eastman Kodak Company. Filters No. 48A and No. 70

were selected for the purpose. Each of these transmits 0.6 per cent. of incident white light, but their range of greatest transmission is very different, No. 48A passing 0.31 per cent. of incident light of wave-length 510 mμ, and 8.2 per cent. at 400 mμ, with a maximum of 27.1 per cent. at 450 mμ, while No. 70 allows 1.0 per cent. to pass at 650 mμ, and 74.5 per cent. at 700 mμ. The one, of course, is red in coloration, the other, a rich blue. There is no physical change of light intensity in passing from one to the other.

A modified Lubbock nest, earth-containing, was set up, consisting of two chambers just of sufficient size to be completely covered by the filters, with a narrow passage between. To test the power of color detection of queens in particular, eight queens from a single colony were introduced, with 24 larvæ, at 1:15 P. M. Mar. 15. The filters were placed over the nest, and it was exposed to intermittent sunshine, at 1:28, with 4 queens and 8 larvæ initially under the red, and 4 queens and 16 larvæ under the blue. The results were these.

Time	Number under red	Number under blue
2:01	3 queens, 8 larvæ	5 queens, 16 larvæ
2:38	3 queens, 16 larvæ	5 queens, 8 larvæ

Though from the same colony, these queens were violently hostile, and enmity and fear of the new surroundings probably rendered the results void of significance. All but one of the queens were removed, and twenty workers introduced. The nest was exposed at 3:02. The queen was then in the passage between the colors, and the workers about evenly distributed between them.

3:58	Queen, 5 workers	15 workers
	Colors reversed at 4:03	
4:23	Queen, 13 workers	7 workers

The results showed how thoroughly fear and unfamiliarity with new surroundings could nullify the value of such experiments. The nest was accordingly left quiet and in total darkness until March 11, at which time it had become well-established, with a good system of chambers and galleries in both

portions of the nest, and larvæ contained in each half. At that time a test was made with a tungsten-filament 23 watt Mazda lamp with reflector at a distance of about 6 cm. used as the source of illumination and Wratten filters No. 78, used merely to screen the light to daylight quality, were superimposed on the color screens. The colony was exposed at 9:03 P. M., at which time 11 larvæ lay in the red, 7 in the blue, and workers were passing rapidly between the two chambers, being about equally distributed. Several larvæ had perished in the interim.

9:20	3 workers, 7 larvæ	Queen, 17 workers, 11 larvæ.

Ten workers and three larvæ were then left in the nest; and it was kept in darkness until March 19. It was fed during this time. On March 19 it was exposed to sunshine, the screening filters being omitted, at 3:21 P. M., at which time 5 workers were under the red and five under the blue.

3:40	5 workers	5 workers	Case I
	Colors reversed		
3:54	7 workers	3 workers	Case II
	Colors reversed		
4:24	1 worker	9 workers	Case III
	Colors reversed		
4:44	6 workers	4 workers	Case IV
	Colors reversed. The electric light, with screening filters, introduced		
5:01	0	10 workers	Case V
	Colors reversed		
5:23	10 workers	0	Case VI

In case I, the ants were indifferent. In case II, 2 ants passed from blue to red, in case III, 2 passed from red to blue, in case IV, 3 passed from red to blue; in case V, 4 passed from red to blue, in case VI the ants were indifferent. In four of the six cases the reversal of colors was followed by a movement of several individuals to follow the color to which they had become accustomed, but no color preference was to be seen.

In the hope that a color-preference general for the species might appear in colonies longer and better established, a colony was next used which had occupied the same quarters—a nest six by eight inches square—for eleven months. Two brood-cham-

bers, one containing 13 cocoons, 3 large larvæ and a good-sized egg packet, and the other a mixed lot of some 25 larvæ, were covered respectively with the red and blue filters, and the colony exposed to sunlight at 1:37 P. M. on November 20, 1929. At 2:15 one larva had been moved from the blue to the red. At 3:05 nothing further had occurred. The same experiment was repeated on December 30, 13 cocoons, 3 large larvæ, 6 small larvæ and eggs being covered in this case by the blue, and 16 larvæ being covered by the red. The colony was exposed at 1:25. At 1:43 every larva had been taken from the red, and either piled outside in full sunlight, or under the blue. It is not believed that a heat effect was responsible for this behavior, since some care was used to exclude it.

On January 26 the expedient was tried with the same colony of leaving the greater portion of it in sunlight initially, and using the filters as refuges. The nest was exposed at 1:24, at which time but one worker and a cocoon were under the red, and nothing was under the blue. At 1:40 the greater portion of the colony was still in full sunlight, but larvæ were being carried under the red, where several had accumulated. At 1:52 larvæ were being actively transferred from the red to the blue. The queen and a large number of workers next congregated under the blue, but at 1:57 only a cocoon and a larva remained under the blue, and nothing was under the red. The ants had returned to full sunshine. The colony used in all this work consisted of a queen, some sixty workers, nearly all of which had matured from eggs laid within the nest, and a hundred or more young.

No conclusion has been drawn from these experiments. Extension and more rigid control may result in the attainment of more definite results. The writer believes that they do indicate, however, a clear ability on the part of *E. harnedi* to differentiate from color to color within the visible human range, but it cannot be shown whether this is due to a true perception of color, or to a mere delicate distinction of light intensities. Although in the second series the factor of varying physical light intensity was controlled, it may be readily argued that one color, lying much nearer to the limits of light-sensitivity of the ants than the other, would appear the darker to them. Nothing whatever is

shown as to the limits of the visible spectrum for *E. harnedi*, since the preference for red or blue, though sometimes quite constant for the individual, becomes widely variant among large numbers of ants.

HEARING

Because of the generous advice and suggestions of Dr. Alan Tower Waterman of Sloane Physics Laboratory, Yale University, the writer has been enabled to conduct experiments which have thoroughly convinced him of the ability of *E. harnedi* to perceive vibrations transmitted through the air. As yet, they have given no indication of the limitations of this auditory power.

Considerable precaution was used, in conducting this work, to eliminate mechanical vibration, so readily perceived by all ants. Thirty-two layers of soft toweling, surmounted by a rubber sponge, were placed on a light cloth-covered table, and this insulating stand was used as a base for the tested colony.

As an indication of the state of vibration existing in the panes of glass forming the floor and the roof of the nest, a wire indicator was fastened with sealing-wax to the upper pane very near to the brood-chamber of the ants. This indicator consisted of an effective length of 15 cm. of extremely light and stiff wire, to which was attached a very light mirror, made by plating a circular microscope slide-cover with a thin coating of silver. The weight of the wire and glass together was 0.25775 ± 0.00005 gm. A beam of light supplied by a tungsten-filament Mazda lamp was allowed to fall on the mirror, and the reflected ray was focused by means of a condensing lens on a distant wall. Such an arrangement is capable of detecting rather minute vibrations, and through the kindness and interest of Frances Parker Haskins, it was possible to keep the spot of light from the mirror under continuous and independent observation.

The range of resonance of the wire-glass system itself can be calculated by use of Young's modulus. Experimentally the fact was determined that the wire did not resonate to sounds of the pitches used, which were all included between low and high C. It was therefore established that any vibrations observed were due to vibrations of the nest itself. Whether these were due to

resonance or to mechanical shock was of course immaterial. It proved impossible to eliminate a slight constant vibration of the wire, but to this the ants paid no attention, and there was no sharp increment of vibration when a pitch was sounded, sufficient to account for the actions of the ants.

The reactions of the ants were often quite striking. Several individuals, and sometimes all those within the field of observation, would simultaneously start forward at the sounding of the pitch, for the production of which a pitch-pipe was used. Frequently larvæ were dragged hurriedly away at once, and very often the ants snapped at one another or at the walls of the chamber in which they were resting. This effect was best seen when an ant was entirely at rest, and the vigorous start which the sudden sound produced left the writer in no doubt that it had been perceived. Individuals varied greatly in the degree of their visible reaction, which, of course, is no indication of a varying power of perception. All tended to become rather readily used to the sudden noise, and often ceased to respond satisfactorily after a few notes. For this reason the tests were begun at the higher end of the scale for certain colonies and at the lower for others. Seven colonies were tested, with the results indicated below. When a reaction to the sound was satisfactory, the fact is indicated by a + sign, when unsatisfactory or negative, by a – .

Colony	C	C	D	D	E	F	F	G	G	A	B♭	B	C	
1	+	+	+	+	+	+	+	+	+	+	+	+	+	Begun low
2	+	+	+	+	+	+	–	+	+	–	+	+	–	Begun high
3	+	+	+	–	–	+	+	+	+	+	+	–	+	Begun low
4	–	–	+	–	–	+	+	+	–	–	+	–	+	Begun high
5	+	–	+	+	+	+	+	+	+	+	–	+	+	Begun low
6	–	–	–	–	–	–	+	–	–	+	+	+	+	Begun high
7	+	+	+	+	+	+	+	+	–	+	+	+	–	Begun low

A male was present in colony 1, and a special series of tests was made on it when 13 days old, but not the least response could be obtained, though the queen and workers of the colony were much agitated, for sound of any pitch. It is believed that this may, incidentally, constitute some evidence for the successful exclusion of mechanical vibration, since the same insect was very sensitive to such disturbance.

Colony 1 had been fed 2 days previous to the test, colony 2, 6 days previously, colony 3, the previous night, colony 4, the previous night, colony 5, 6 days previously, colony 6, 6 days previously, colony 7, 6 days previously. No great difference was to be seen between the sensitiveness of queens and workers. In colony 1 the old queen was very slightly less sensitive than the workers. Young queens were quite markedly unresponsive. In colony 2, the brood-queen was more sensitive than the workers, and the same was true in colony 7.

A considerable difference in responsiveness is to be seen to differently pitched notes, which was fairly consistent. Thus three nests showed unresponsiveness to the pitches of C, D, E, and G, two to C, A, B, and C, and one to D, F, F, G, and B♭. No pitch was responded to by less than three colonies, indicating rather considerable powers of perception within this range, a fact rather surprising to the writer.

SMELL, TASTE, TOUCH

That the sense of smell is well developed is indicated by the rapidity with which food placed at a distance is sensed and the accuracy with which its position is located, together with the facility with which alien individuals of the same species are detected. The sense of taste is present and rather delicate, as evidenced by the discrimination used in bringing in apparently acceptable food materials after they have been sampled. The slight touch or jar which is required to startle an inert individual is sufficient evidence of the delicacy of the generally distrbuted tactile sense.

DESCRIPTIONS OF NEW HESPERIIDÆ FROM TRINIDAD, B. W. I., AND SOUTH AMERICA (LEPIDOPTERA-RHOPALOCERA)

BY E. L. BELL

Cobalus mubevensis new species, (Plate XXXX, Fig. 1).

Male. Upper side. Dark brown with a reddish sheen on both wings and olivaceous hairing at the base. Primaries with six white-hyaline spots: a sagittate spot in interspace 2, just before the center of the vein and extending across the interspace, beyond this, in interspace 3 is an oblong spot extending nearly across the interspace, two small spots in the cell toward the end, one on the upper and one on the lower margin, two very minute subapical spots.

Beneath. Both wings slightly paler brown than above and with a thread-like pale terminal line. Primaries with the spots of the upper side repeated and a lighter area at the anal angle. Secondaries with two very minute white discal spots and one in the cell-end.

Fringes brown, paler at the tip. Body, above blackish with olivaceous hairing, beneath, greenish on the thorax, the abdomen pale brown with a double yellow line. Legs brown. Head greenish. Palpi above black and fulvous, beneath mostly fulvous with some black hairs intermixed. Pectus greenish and brown. Collar, shoulder-covers and tegulæ greenish-brown. Antennæ black above, beneath black minutely scaled with yellow at the joints, the club and apiculus yellow.

Female. Similar to the male, the spots of the primaries larger and an additional small whitish spot on vein 1 a little beyond the center and also one more subapical spot. The spots on the underside of the secondaries remain extremely minute as in the male.

Expanse: male, 34 mm.; female, 40 mm.

Type material. Holotype male, Mubevo, Paraguay, December; allotype female, Massaranduba-Blumenau, Brazil, in collection of the author.

The male of this species bears some resemblance to the Draudt figure (Seitz, Macrolep. of the World, vol. 5, pl. 185 i) of *Cobalus* "*trimaculata*" (*trimaculatus*) Plotz, but it is smaller and the spots of the primaries are also somewhat smaller, that in interspace two being sagittate, not triangular, and has the small subapical spots which are lacking in *trimaculatus*. There is a

specimen in the writer's collection which is identified as *trimaculatus* and which very closely agrees with the Draudt figure referred to and which is a *Rhinthon* and not a *Cobalus*.

Oenus kayei new species. (Plate XXXX, Fig. 2).

Male. Upper side. Primaries and secondaries immaculate, brown. Fringes concolorous, slightly paler at the tip.

Beneath. Paler brown than above, primaries have a hazy suggestion of discal and subapical spots, outside of which the color of the wing is paler than toward the base, anal angle paler, a short yellow streak at the base on the under side of the costal vein. Secondaries paler in the disc which is crossed in the center by a darker brown band.

Body brown above, paler brown beneath. Legs dark brown with some yellowish hairs on the anterior and posterior femora. Head with brown and yellowish-brown hairs. Palpi brown at the tip, greyish beneath. Pectus greyish. Antennæ black above, beneath black except the club is yellow and the apiculus red.

The stigma of the primaries is a short narrow stripe on the upper side of vein 2 slanting across the angle, a short piece below vein 2 slightly oblique and a longer stripe below this to vein 1; it is similar to that shown in the Biologia Cent.-Amer., plate 98, figure 40, as *Oenus pyste* Godman.

Expanse: 36 mm.

Type material. Holotype male, Trinidad, B. W. I., April 10, in collection of the author.

Named for Mr. W. J. Kaye, F.E.S., of London, England.

This species seems to differ in superficial appearance from any of the species in the genus mentioned by Draudt, in Seitz, Macrolep. of the World.

Perimeles stollmeyeri new species, (Plate XXXX, Fig. 3).

Male. Upper side. Primaries brown sprinkled with fulvous scales, heaviest toward the base. Secondaries brown, the discal and basal area with fulvous hairs.

Beneath. Primaries paler brown along the costa, apical area and outer margin, the stigma of the upper side prominently shown on this side and from this to the base blackish, some yellow hairs in the cell and on the costal margin. Secondaries immaculate, very pale brown with a lilacine tint.

Fringes greyish. Thorax above olive-greenish, abdomen brown, beneath greyish. Head greenish and yellow hairs. Palpi brownish at the tip, beneath yellowish white with a few black hairs. Pectus yellowish-white. Legs pale brown and grey. Antennæ black above, beneath spotted with yellow at the joints and a yellow spot in the basal half of the club.

Expanse: 28 mm.

Type material. Holotype male, Pt. of Spain, (Botanical Gardens), Trinidad, B. W. I., April, in collection of the author.

Named for Mr. C. Rex. Stollmeyer, of Pt. of Spain, Trinidad.

The stigma of the primaries is of the same general form as that of *Perimeles remus* Fabricius, consisting of a stripe extending along the median vein from the rise of vein 3 to vein 2, a short piece just below vein 2 and another piece below that to vein 1.

This species while of the same general wing shape as *remus* differs a great deal in coloration from that species, however, the form of the genitalia is very much the same, the extremely long saccus and ædœagus with split termination, the uncus and the form of the short clasper is quite similar in both.

Eutychide insulanus new species, (Plate XXXX, Fig. 4).

Male. Upper side. Primaries and secondaries brown. Primaries with four white-hyaline spots: a narrow one between veins 2 and 3 extending from just below the rise of vein 3 almost to vein 2, a roundish one between veins 3 and 4 just beyond the cell-end, two small subapical spots, the lower one slightly the larger.

Beneath. Primaries have the spots of the upper side repeated, the extreme costal margin edged with black, below this almost to the cell red, a paler spot about the center of the costa and another above the subapical spots, below the apex overscaled with lilacine, the rest of the wing brownish with a white streak between veins 1 and 2. Secondaries red, the basal half lightly overscaled with lilacine as is also the outer margin below the outer angle, leaving a red band across the center of the wing, abdominal fold brown.

Fringes brown, slightly paler than the wings. The body is rubbed but appears to have been brown above, beneath brown, the abdomen yellow with a brown stripe in the center. Head dark brown with some red-fulvous hairs at the sides and behind the eyes. Palpi dark brown at the tip, beneath fulvous and dark brown intermixed, red-fulvous at the sides. Pectus dark brown with some fulvous hairs. Legs dark brown with fulvous scales and hairs. Antennæ black above, below black with a yellow spot at the base of the club and one at the base of the apiculus.

The stigma of the primaries is of the form typical of this genus.

Expanse: ·26 mm.

Type material. Holotype male, Trinidad, B. W. I., April 11, in collection of the author.

The form of the genitalia is somewhat similar to that of *cin-*

gulicormis Herrich-Schaffer but the claspers terminate differently. In superficial appearance *insulanus* differs from *cingulicormis* in the fewer and smaller hyaline spots and in the very different maculation of the underside of the secondaries.

Megistias ignarus new species, (Plate XXXX, Fig. 5).

Male. Upper side. Primaries and secondaries reddish-brown, primaries with three hazy subapical spots, but little paler than the ground color. Secondaries immaculate. Fringes a little paler than the wings.

Beneath. Wings slightly paler than above, primaries with two hazy, ill-defined discal spots, one between veins 2 and 3 and one between veins 3 and 4, the hazy subapical spots repeated; pale brown on the inner margin and as far as vein 2 at the anal angle; a darker submarginal line followed by a pale marginal line and a darker thread-like line at the base of the fringes. Fringes slightly paler with darker spots especially toward the apex. Secondaries a little darker than the primaries, with four hazy, ill-defined, lighter brownish spots in a curved discal row and one in the cell-end; abdominal fold paler brown; the submarginal, and terminal lines and the one at the base of the fringes similar to those of the primaries.

Body brownish on both sides. Head, collar and shoulder-covers brownish with some fulvous hairs. Tegulæ brownish. Palpi brownish intermixed with fulvous. Legs brownish. Antennæ black, beneath minutely scaled yellow at the joints, the club and apiculus yellow.

Expanse: 28 mm.

Type material. Holotype male, Santa Cruz, Bolivia, in collection of the author; one male paratype, Surinam, in collection of the Academy of Natural Sciences, Philadelphia, Penna.

This is one of the small obscure insects which cannot be identified satisfactorily from either published description or figure and distinguished from many which bear a similar superficial appearance. The form of the genitalia, however, will readily identify this species.

Carystus coxeyi new species, (Plate XXXX, Fig. 6).

Male. Upper side. Primaries and secondaries dark brown; primaries with ten white-hyaline spots; two a little beyond the center of the cell one above the other, a subquadrate one in interspace 1, a larger one broader at its base than the apex crossing interspace 2 at about the center, another crossing interspace 3, a smaller one in interspace 4, and a minute one (absent in one paratype) in interspace 5, these five forming a transverse discal row, three subapical spots the lower of which is the larger and the middle one the smaller. Secondaries with a large, roundish, white spot, not sharply defined on the lower edge, this spot extends further downward

than the spot on the under side of the wing and the dark ground color showing through in this area makes it appear pale bluish. A stripe of white on the inner margin of the abdominal fold.

Beneath. Primaries with the apical half dark brownish-red, the rest of the wing blackish-brown, paler along the inner margin; spots of the upper side repeated, that in interspace 1 elongated and more or less notched on the outer edge. Secondaries deep brownish-red, abdominal fold brown with the inner edge rusty-red; an oblong white or yellowish-white spot across the center of the wing and lower corner of the cell, extending from the center of the inner margin of the abdominal fold to almost the outer angle and somewhat rounded at the outer end.

Body, thorax above dark brown with some greenish hairs, beneath with greenish and brownish-red hairs; abdomen above blackish-brown, beneath bright yellow. Head dark brown with a greenish reflection. Palpi blackish-brown above and beneath, rusty-red at the sides and base. Pectus blackish-brown. Shoulder-covers brown bordered exteriorly with brownish-red. Collar dark brown bordered interiorly with brownish-red. Tegulæ dark brownish. Antennæ black, the apiculus somewhat reddish beneath. Legs dark brown, striped with brownish-red or yellow. Fringes of primaries white at the anal angle and brown from there to the apex; of the secondaries white broadly crossed with dark brown at the vein ends. The male has no stigma.

Expanse: 50 mm.

Type material. Holotype male, Ecuador, one male paratype, Ecuador, one male paratype, Chanchamayo, Peru, in collection of the author; one male paratype, Ecuador, in collection of the Academy of Natural Sciences, Philadelphia, Penna.

Named for my friend, Mr. W. Judson Coxey, of Philadelphia, Penna.

This handsome species does not closely resemble any other in the genus with which the author is familiar, but the general superficial appearance and the form of the genitalia seem to ally it to *Carystus*.

Eutocus (?) illepidus new species, (Plate XXXX, Fig. 7).

Male. Upper side. Primaries and secondaries blackish-brown, immaculate.

Beneath, primaries dark brown, blackish toward the base a little paler on the inner margin; secondaries with a reddish tinge. Fringes dark brown.

The stigma of the primaries consists of a small, inconspicuous sagittate patch in the angle at the base of interspace 2. The primaries also have a tuft of rather long hairs extending from the base of interspace 1 to about the center of the interspace.

Body above and beneath dark brown. Legs brown with a paler stripe. Head dark brown with some paler brown hairs. Collar and shoulder-covers dark brown with some paler hairs. Tegulæ dark brown. Palpi dark brown with some yellowish hairs. Pectus dark brown and yellowish. Antennæ black, yellowish at the base of the club beneath.

Expanse: 24 mm.

Type material. Holotype male, Mubevo, Paraguay, December, in collection of the author.

This is one of the small blackish species resembling *Mnasitheus simplicissimus* Herrich-Schaffer, which has no stigma, and *Mnasitheus cephis* Godman, which has a different form of stigma; from the other *Eutocus* species it may be distinguished by the form of the male genitalia. *Illepidus* may not be strictly congeneric with the other *Eutocus* species, but it seems to fit better in this genus than elsewhere.

Thracides (?) currani new species, (Plate XXXX, Fig. 8).

Male. Upper side. Primaries dark brown, with a patch of slightly longer hair-like scales below the median vein in interspace 1, and a small thickened patch of darker scales on vein 1 at about the center, forming a rather indistinct stigma. Fringes black. Secondaries dark brown with the margin above the costal vein yellow; a distinct tuft of long hairs from the base of the cell extending to the center of the wing. Fringes reddish, above the outer angle white.

Beneath. Primaries, inner margin below vein 1 bright yellow, interspace 1 black in the basal third, then bright yellow in the center, then black and then red, interspace 2 is black in the basal third, then reddish-yellow, then black, and then red, interspace 3 black at the base, then dark reddish-yellow, then red, the balance of the apical area of the wing is deep red with three yellow spots at the apex and several whitish stripes between the veins in front of and above the cell-end, the cell is black with a red border on the upper side, a whitish spot at the end in the upper angle and a smaller red-yellow spot in the lower angle, at the base whitish, above the cell is a bright yellow stripe extending from the base to almost the cell-end where it is extended upward to the costal margin spotlike, above this stripe the costal margin is a deep, dark red in approximately the basal half, the extreme costal edge is black from the base to the apex. Corresponding to the thickened patch of scales on vein 1 on the upper side is a slightly larger, oval area of differently formed and paler scales, which stand out noticeably and through the center of which runs vein 1.

Secondaries with the abdominal fold bright yellow, the ground color of the wing is bright brick red, in each interspace with a long white stripe,

nearly as wide as the interspace, and varying in length, with a narrow, irregular line of the ground color running through them in the outer three-quarters of the wing, at the end and below the cell is an irregular area of the red ground color deeper in tone, two white stripes in the cell, the basal two-thirds of the costal margin is edged with black, prominently so just before the base, the outer angle somewhat yellowish. Fringes reddish with some dark hairs intermixed at the end of the veins, above the outer angle white.

Body above blackish, beneath the thorax has whitish hairs, the abdomen yellow. Legs fulvous. Head red-brown. Palpi above red-brown, beneath yellow at the base shading to red at the tip. Collar dark red. Shoulder-covers dark red and brown. Tegulæ blackish with a dark red edge on the outer side at the base. Pectus red-yellow. Antennæ black above and beneath in the basal two-thirds then yellow edged with black at the joints, club black, apiculus yellow.

Expanse: 50 mm.

Type material. Holotype male, Dutch Guiana, March, in collection of the author.

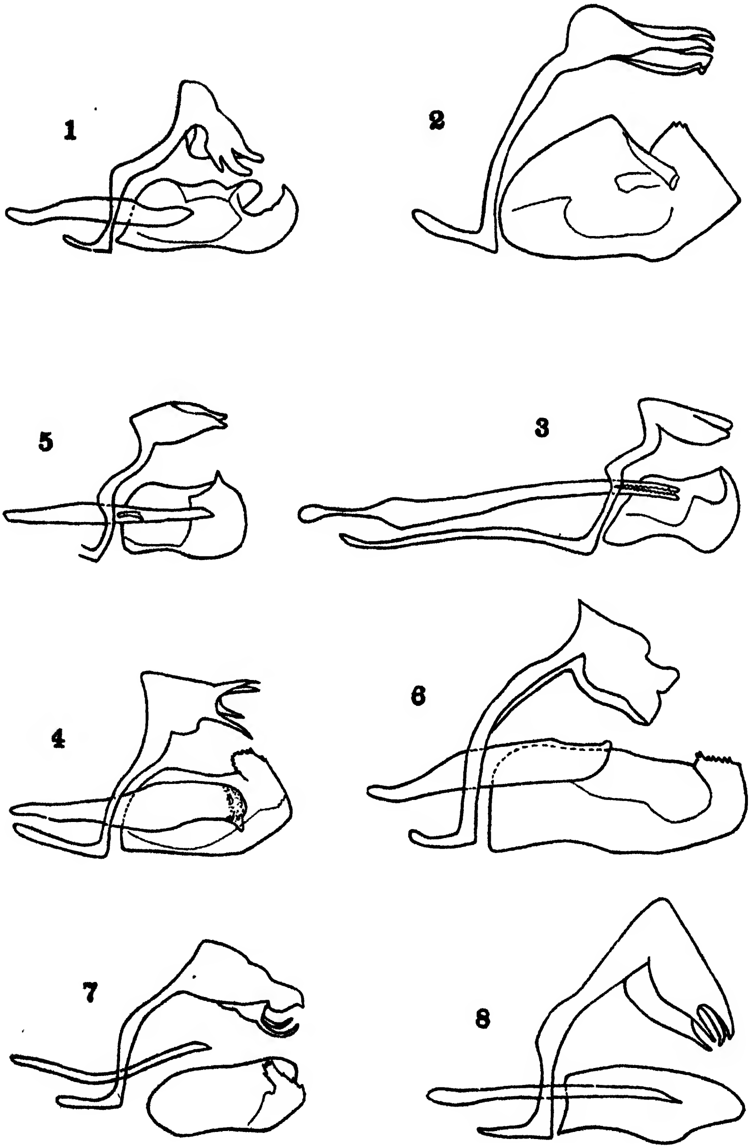
This insect probably does not belong in the genus *Thracides* but neither does it correspond with any other genus known to the writer and is placed here provisionally on account of the general resemblance in wing shape to some of the *Thracides* species and because in the form of the uncus, claspers and short saccus of the genitalia it also resembles some of the species in that genus.

Named for my friend Mr. C. H. Curran, of New York City.

All of the above measurements of expanse are from the center of the thorax to the apex of the primary × 2.

PLATE XXXX

Figure 1. *Cobalus mubevensis* new species.
Figure 2. *Oenus kayei* new species.
Figure 3. *Perimeles stollmeyeri* new species.
Figure 4. *Eutychide insulanus* new species.
Figure 5. *Megistias ignarus* new species.
Figure 6. *Carystus coxeyi* new species.
Figure 7. *Eutocus* (?) *illepidus* new species.
Figure 8. *Thracides* (?) *currani* new species.



HESPERIIDÆ

TABANIDÆ OF THE PENINSULA OF YUCATAN, MEXICO, WITH DESCRIPTIONS OF NEW SPECIES

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The present paper covers the Tabanidæ known at present from the Mexican portion of the Peninsula of Yucatan, including the States of Campeche and Yucatan and the Territory of Quintana Roo. It is based in the first place upon extensive collections made, in 1929 and 1930, by the expedition organized by the Department of Tropical Medicine of Harvard Medical School, under the auspices of the Carnegie Institution of Washington, D. C., and under the leadership of Dr. George C. Shattuck. I have also studied a few Yucatan specimens at the United States National Museum and a cotype of *Tabanus hæmagogus* at the American Museum of Natural History.

Subfamily Pangoniinæ

Tribe *Chrysopini*

Chrysops variegata (Degeer)

Tabanus variegatus de Geer, 1776, 'Mém. pour servir à l'Hist. des Ins.,' VI, p. 230, Pl. XXX, figs. 7–8 (♀; Surinam). Not *Tabanus variegatus* Fabricius, 1805.

Chrysops variegata J. Bequaert, 1926, 'Medical Rept. Hamilton Rice 7th Exped. Amazon,' p. 220, fig. 7*a*.

Tabanus costatus Fabricius, 1794, 'Ent. Syst.,' IV, p. 373 (without locality).

Heterochrysops costatus Kröber, 1926, Stettin Ent. Zeitg., LXXXVII, pp. 213 and 231 (♀ ♂); 1929, Deutsch. Ent. Zeitschr., (1928), p. 426.

Heterochrysops variegatus Kröber, 1929, Ann. Naturh. Mus. Wien, XLIII, p. 244.

Chichen Itzá, State of Yucatan, one female, February, 1930, (Dr. G. C. Shattuck).

I have fully discussed the synonymy and distribution of *C. variegata* in a previous paper. This fly reaches its northern limit in Mexico, where it has been taken also at San Rafael in Vera Cruz, Teapa in Tabasco, and the Volcano Colima in Jalisco. It has never been found north of the Tropic of Cancer.

Kröber (1925) has attempted to define a number of varieties of this species, but I doubt whether any of them are worthy of recognition by name. The var. *subfascipennis* (Macquart) appears to be based upon poorly preserved specimens, in which the longitudinal bands of the thorax were more or less faded. The var. *peruviensis* Kröber is separated from the typical form by slight differences in the extent of the dark markings of the wings, a character which is subject to much individual variation. As for the var. *venezuelensis* Kröber, it seems to differ from *C. crucians* var. *ecuadorensis* (Ad. Lutz) only in the hyaline spot of the discal cell. Moreover, *C. crucians* Wiedemann is, in my opinion, closely allied to *C. variegata*, the shape of the antennæ of both species being extremely similar. This character is much more important in indicating true relationships than the presence or absence of a hyaline spot in the discal cell, according to which Kröber places these two species in different genera or subgenera.

In a recent paper, Curran (1931, American Museum Novitates, No. 456, p. 3) claims that in *C. variegata* "the spurs on the posterior tibiæ are so small as to be almost wanting, and I am not sure that they are always present." He regards this species as "rather aberrant," and in his key infers that the genus *Chrysops* might not always be readily separable from *Diachlorus*. Although the tibial spurs of *C. variegata* are smaller than those of some other species of the genus, I have had no difficulty in finding them in 125 specimens, when the proper magnification was used. It is, of course, possible that these structures may sometimes be broken off accidentally. The characters given in Curran's key to differentiate between *Diachlorus* and *Chrysops* do not apply to all the species of these genera. Some species of *Chrysops* have the face evenly convex, without even a trace of swellings; while the width of the frons varies considerably in both genera. The two are, however, readily separated (apart

from the presence or absence of tibial hind spurs) by the different structure of the antennæ. In *Diachlorus*, the antennæ are decidedly of the *Tabanus*-type, with the second segment short, less than half the length of the first.

Chrysops incisa (Macquart)

Chrysops incisus Macquart, 1845, Mém. Soc. Sci. Lille, (1844), p. 176, Pl. IV, figs. 12 and 12*a*; 1846, 'Dipt. Exot.,' Suppl. I, p. 44, Pl. IV, figs. 12 and 12*a* (♀; New Grenada = Colombia). Walker, 1854, 'List Dipt. Brit. Mus.,' V, Suppl. 1, p. 285. Schiner, 1868, 'Reise Novara, Zool., II, Abt. 1, Vol. B, Dipt.,' p. 104 (♀ ♂). Hunter, 1900, Trans. Amer. Ent. Soc., XXVII, p. 135. Ricardo, 1901, Ann. Mag. Nat. Hist., (7) VIII, pp. 310 and 312 (♀ ♂). Kertész, 1908, 'Cat. Dipt.,' III, p. 188. Surcouf, 1921, 'Gen. Insect., Taban.,' p. 152. Hine, 1925, Occas. Pap. Mus. Zool. Univ. Michigan, No. 162, p. 14.

Southeast of Peto, Territory of Quintana Roo, June 5 to 10, 1929, three females attacking horses (G. C. Shattuck).

These specimens have a broad pale band, covered with yellowish hair, on each side of the mesonotum (above the wing), and a large hyaline emargination of the black cross-band of the wing (extending from the hind margin to near the discal cell). The sides of the first and second tergites are extensively yellowish and the pale median triangles of the abdomen are much larger than in *C. latifasciata* Bellardi (= *neglectus* Williston), *C. leucospila* Wiedemann, and *C. melæna* Hine, all of which differ also from *C. incisa* in lacking the yellow stripes on the sides of the mesonotum. My interpretation of *C. incisa* agrees with that of Hine (1925). Kröber's *incisa* (1925, Konowia, IV, pp. 215, 225, 229 and 344, Pl. I, fig. 13; Pl. III, figs.; and Pl. V, figs.; ♀ ♂) appears to be based upon a mixture of at least two species. His main description of the female seems to fit best *C. melæna* Hine, since the thorax is said to be unstriped and the hyaline marginal spot of the fifth posterior cell to invade the fourth. He mentions, however, that in three females the hyaline spot is restricted to the fifth posterior cell and his figure of the wing appears to be drawn from one of these specimens, which ob-

viously were *C. latifasciata* Bellardi (as interpreted by Hine). To attempt the identification of Kröber's supposed male of *C. incisa* would be mere guesswork; the locality of this male is not given.

Although I have followed Hine's interpretation of *C. incisa,* it must be admitted that Macquart's description could equally well cover any of several species of this group. It might even be claimed that, since Macquart did not mention the lateral stripes of the thorax, he did not have before him Hine's *C. incisa,* but rather *C. melæna* Hine. On the other hand, in Macquart's figure, the hyaline spot of the hind margin of the black crossband of the wing is seemingly too large for *C. melæna,* though it is smaller than in the Central American specimens here referred to *C. incisa.* It is doubtful whether, in the absence of Macquart's type, any certainty can be reached in the matter. Kröber did not study the type.

Tribe *Pangoniini*

Esenbeckia illota (Williston)

Pangonia illota Williston, 1901, 'Biol. Centr.-Amer.,' Dipt., I, pp. 253 and 254 (♀; Ruatan Island, Honduras). Aldrich, 1905, 'Cat. North Amer. Dipt.,' p. 193. Kertész, 1908, 'Cat. Dipt.,' III, p. 155.

Pangonius illota Surcouf, 1921, 'Gen. Insect., Taban.,' p. 128. Hine, 1925, Occas. Papers Mus. Zool. Univ. Michigan, No. 162, p. 5.

Esenbeckia illota Enderlein, 1925, Mitt. Zool. Mus. Berlin, XI, 2, p. 288.

Esenbeckia ferruginea J. Bequaert, 1925, '13th Rept. United Fruit Co., Med. Dept.,' (1924), p. 25. Not of Macquart, 1838.

Territory of Quintana Roo, one female (U. S. Nat. Mus.).

I have seen this species also from British Honduras (Benque Viejo) and the Republic of Honduras (Prieta). Superficially it resembles *E. ferruginea* (Macquart), of South America (Venezuela and Brazil), with which I formerly confused it. The two species may be separated by the color of the abdomen: in *ferruginea,* the first and second segments are colored alike and

bear the same yellowish pubescence; whereas in *illota*, the first segment is ivory-white, much paler than the yellowish second segment, and covered with whitish hairs.

Scione aurulans (Wiedemann)

Pangonia aurulans Wiedemann, 1830, 'Aussereurop. Zweifl. Ins.,' II, p. 620 (♀; Mexico). Walker, 1854, 'List Dipt. Brit. Mus.,' V, Suppl. 1, p. 120. Osten Sacken, 1878, Smithson. Miscell. Coll., No. 270, p. 52. Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 170. Aldrich, 1905, 'Cat. North Amer. Dipt.,' p. 193. Kertész, 1908, 'Cat. Dipt.,' III, p. 152.

Pangonius aurulans Surcouf, 1921, 'Gen. Insect., Taban.,' p. 127.

Scione aurulans Hine, 1920, Ohio Jl. Sci., XX, p. 314; 1925, Occas. Papers Mus. Zool. Univ. Michigan, No. 162, p. 9.

Rhinotriclista aurulans Enderlein, 1925, Mitt. Zool. Mus. Berlin, XI, 2, p. 302. Kröber, 1930, Stettin. Ent. Zeitg., XCI, 2, p. 147 (♀ ♂).

Pangonia rostrifera Bellardi, 1859, 'Saggio Ditter. Messic.,' I, p. 47 (♀ ♂; Mexico). Osten Sacken, 1878, Smithson. Miscell. Coll., No. 270, p. 52. Williston, 1901, 'Biol. Centr.-Amer.,' Dipt., I, pp. 252 and 253. Aldrich, 1905, 'Cat. North Amer. Dipt.,' p. 193.

Pangonia (Erephrosis) rostrifera Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 169.

Pangonia (Erephopsis) rostrifera Kertész, 1908, 'Cat. Dipt.,' III, p. 166.

Erephopsis rostrifera Surcouf, 1921, 'Gen. Insect., Taban.,' p. 120.

Scione lurida Enderlein, 1925, Mitt. Zool. Mus. Berlin, XI, 2, p. 301 (♀; Colombia and Manatee, British Honduras). Szilády, 1926, Biologica Hungarica, I, 7, p. 28.

Territory of Quintana Roo, one female (U. S. Nat. Mus.).

I have seen this tabanid also from Mexico, British Honduras (Benque Viejo), Guatemala (Nalsum; Coban; Puerto Barrios; El Rancho; Cayuga), the Republic of Honduras (Lombardia), and Colombia (Vista Nieve, San Lorenzo Mountains). Hine writes of this species: "It is an annoying fly where it abounds.

It appeared to keep close to the ground and with its long proboscis had no trouble biting through one's trousers. More than a score of specimens were actually counted on my clothing at one time."

Hine appears to be correct in synonymizing *Pangonia rostrifera* Bellardi with Wiedemann's *aurulans*, both of which were described from Mexico. At the Museum of Comparative Zoölogy, there is a female from Mexico, labelled "*rostrifera* Bell." by Osten Sacken, which agrees entirely with Hine's and my idea of *Scione aurulans*. Hine regards *Diclisa misera* Osten Sacken (1886, 'Biol. Centr.-Amer.,' Dipt., I, p. 47; ♀; Lanquin and Panima, Guatemala) also as identical with *S. aurulans*. According to Enderlein, however, *misera* is a distinct species, which has the pubescence of the dorsum of the abdomen brownish-black ("schwarzbraun"), except for rather broad apical margins of golden-yellow hairs. In *aurulans*, the pubescence is golden-yellow over the entire dorsal surface. In all the specimens I have seen, the pubescence is as described by Enderlein for *aurulans*. *S. lurida* was evidently based upon a *S. aurulans* with abnormal venation.

Enderlein's "genus" *Rhinotriclista* differs from *Scione* only in that the second branch of the fourth longitudinal vein runs out to the hind margin, thus completely separating the second and third posterior cells; whereas in *Scione* this branch stops before the margin. I cannot believe that so slight and variable a peculiarity of the venation is of generic or even subgeneric value. Kröber recently (1930) reached the same conclusion, although he retained the name *Rhinotriclista* in his grouping of the species.

Subfamily TABANINÆ

Tribe *Tabanini*

Tabanus Linnæus

The following key will enable one to name the species of this genus known thus far from the Peninsula of Yucatan.

1. Second posterior cell closed and petiolate before the hind margin of the wing; fork of third longitudinal vein with appendix. Reddish-brown; abdomen with a median row of small and rather faint triangles of

yellowish hairs on the hind margins of the tergites; scutellum with a large, velvety-black spot, enclosed in a ring of yellowish hair. Length, 15 to 17 mm. . . . . *T. oculus* Walker.

Second posterior cell open at the hind margin; fork of third vein as a rule without appendix. Scutellum without conspicuous black spot .. 2

2. Abdomen reddish-brown to black, some segments partly or mostly covered with white or yellow pile, forming cross-bands, sometimes widened in the middle and at the sides . . . 3

Abdomen reddish-brown to blackish, with one or three longitudinal pale stripes or irregular rows of pale triangles 4

3. Legs and palpi entirely black; antennæ mostly reddish. Dorsum of thorax and most of second and fourth tergites covered with yellow or white pile. Length, 9 to 11 mm. .. *T. itzarum* J. Bequaert.

Legs black, with all the tibiæ very extensively white; palpi and antennæ black; scutellum and sides of thoracic dorsum white-haired; second to sixth tergites with white apical margins, much broader on the second and fourth than on the others. Length, 11 to 13 mm. *T. leucaspis* Wiedemann.

4. Abdomen reddish-brown to blackish-brown, with a median, longitudinal, irregular but continuous, pale stripe (often faint), consisting of elongate triangles; no lateral spots. Wings somewhat infuscated, clearer in the center of the cells. Length, 10 to 15 mm. *T. hæmagogus* Williston.

Abdomen dorsally with three pale stripes or with three rows of pale spots 5

5. Frons very wide, nearly parallel-sided, only a little more than twice as long as wide . . 6

Frons much narrower, slightly narrowed below, four to six times as long as wide .. 7

6. Fork of third vein with long appendix. Abdomen with a pale middorsal stripe, connected with the pale hind margins of the several tergites; the lateral pale spots transverse or oval, often small, and generally free from the hind margins. Frontal callosity occupying the entire width, rectangular, shiny black. Length, 9 to 11 mm. *T. littoreus* Hine.

Fork of third vein without appendix. "Abdomen brownish-yellow; a well-defined, moderately broad median yellowish-white pollinose vitta of even width, becoming indistinct on sixth segment, a brown vitta on each side of and limiting the median vitta, forming a triangle on each side on third and subarcuate marking on each side on second segment; but these brown vittæ are faintly represented in full width on second and third segments by a shading of brown supplementing the triangular and arcuate markings; on the outside of the brown vittæ on each side there is a lateral yellowish-white pollinose vitta like the median one but not so distinct; while still outside of this is

another lateral brown vitta limiting the lateral white one on the inside and parallel with the edge of the abdomen on the outside.'' Frontal callosity nearly square, rounded on upper corners, brown. Length, 8.5 mm. .... *T. campechianus* Townsend.

7. Frons about six times as long as wide at the subcallus. Third antennal segment short and broad, hardly crescent-shaped, the basal portion rather evenly produced above into a low, blunt triangle. Length, 9 to 12 mm. . .... *T. yucatanus* Townsend.

   Frons a little over four times as long as wide at the subcallus. Third antennal segment elongate and slender, distinctly crescent-shaped, the upper projection asymmetrical, with a prominent, blunt edge. Length, 11 to 14 mm. .. . . *T. maya* J. Bequaert.

Tabanus oculus Walker

Tabanus oculus Walker, 1848, 'List Dipt. Brit. Mus.,' I, p. 157 (♀; Honduras and Colombia); 1854, *loc. cit.*, V, Suppl. 1, p. 190. Osten Sacken, 1878, Smithson. Miscell. Coll., No. 270, p. 61. Hunter, 1901, Trans. Amer. Ent. Soc., XXVII, p. 146. Bodkin and Cleare, 1916, Bull. Ent. Res., VII, p. 187. Hine, 1925, Occas. Pap. Mus. Zool. Univ. Michigan, No. 162, p. 23.

Bellardia oculus Kröber, 1929, Zoolog. Anzeiger, LXXXIII, p. 121.

Tabanus bipartitus Walker, 1848, 'List Dipt. Brit. Mus.,' I, p. 158 (♀; Honduras); 1854, *loc. cit.*, V, Suppl. 1, p. 190. Osten Sacken, 1878, Smithson. Miscell. Coll., No. 270, p. 60.

Tabanus albo-notatus Bellardi, 1859, 'Saggio Ditter. Messic.,' I, p. 56, Pl. II, fig. 5 (♀; Mexico and Tampico). Osten Sacken, 1878, Smithson. Miscell. Coll., No. 270, p. 60; 1886, 'Biol. Centr.-Amer.,' Dipt. I, p. 55. Hunter, 1901, Trans. Amer. Ent. Soc., XXVII, p. 139. Williston, 1901, 'Biol. Centr.-Amer.,' Dipt., I, pp. 257 and 260. Aldrich, 1905, 'Cat. North Amer. Dipt.,' p. 200. Kertész, 1908, 'Cat. Dipt.,' III, p. 219. Surcouf, 1921, 'Gen. Insect., Taban.,' p. 59. J. Bequaert, 1925, '13th Rept. United Fruit Co., Med. Dept.,' (1924), p. 206.

Bellardia albonotata Rondani, 1863, Arch. per la Zool., Modena, III, 1, p. 81.

Chichen Itzá, State of Yucatan, one female, June 9, 1929. Southeast of Peto, Territory of Quintana Roo, two females, June

5–10, 1929 (G. C. Shattuck). Colonia Santa Maria (near Puerto Morelos), northern part of Quintana Roo, May 13 to 22, 1929, one female (G. C. Shattuck).

I have taken this species also at Sangrelaya, Rep. Honduras, April 13, 1924. It is readily recognized by the large dark spot of the scutellum, surrounded by a pale margin, the closed and stalked first posterior cell, and the long appendix to the fork of the third longitudinal vein. In life the eye usually is dark purple with two bright green cross-bands, one above and one below the middle; more rarely with a third, shorter band in the upper part (Fig. 1*a*).

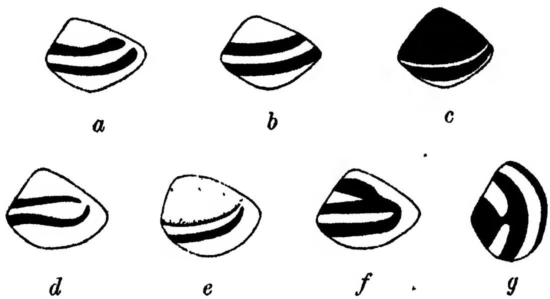

FIG. 1. Markings of the eyes of Yucatan Tabanidæ, in life: *a*, *Tabanus oculus* Walker, female; *b*, *Tabanus littoreus* Hine, female; *c*, *T. littoreus*, male; *d*, *Tabanus yucatanus* Townsend, female; *e*, *T. yucatanus*, male; *f*, *Tabanus maya* J. Bequaert, female; *g*, *Diachlorus ferrugatus* (Fabricius), female. The bright green areas are marked in black, the purple areas in white, and the greenish-purple areas are dotted.

At present *T. oculus* is known with certainty from Mexico (Tampico; Vera Cruz; Teapa and Frontera in Tabasco; Yucatan), Guatemala (Morales), British Honduras (River Sarstoon), and the Republic of Honduras. Walker's record from Colombia, and Bodkin and Cleare's from British Guiana are open to question, since other similarly colored species are found in northern South America.

Tabanus hæmagogus Williston

Tabanus hæmagogus Williston, 1901, 'Biol. Centr.-Amer.,' Dipt., I, pp. 258 and 261 (♀ ♂; Temax in northern Yucatan, Mexico). Aldrich, 1905, 'Cat. North Amer. Dipt.,' p.

204. Kertész, 1908, 'Cat. Dipt.,' III, p. 248. Surcouf, 1921, 'Gen. Insect., Taban.,' p. 70. Hine, 1925, Occas. Pap. Mus. Zool. Univ. Michigan, No. 162, p. 31.

Tabanus filiolus Williston, 1901, 'Biol. Centr.-Amer.,' Dipt., I, pp. 258 and 261 (♀ ♂; northern Yucatan, Mexico). Aldrich, 1905, 'Cat. North Amer. Dipt.,' p. 203. Kertész, 1908, 'Cat. Dipt.,' III, p. 242. Surcouf, 1921, 'Gen. Insect., Taban.,' p. 68.

Chichen Itzá, State of Yucatan, numerous females and two males, June 16 to 30, 1929. Chankom, State of Yucatan, June 20, 1929. Merida, State of Yucatan, common, July 2 to 8, 1929. Izamal, State of Yucatan, July 4, 1929. This species was also very common along the railroad between Dzitas and Merida, numerous specimens entering the coaches at every stop, on July 1st.

I have compared my specimens with a female "cotype" of *T. hæmagogus,* labelled "N. Yucatan. Gaumer," formerly in Williston's collection and now at the American Museum of Natural History. Without this comparison, I could not have been certain of my identification, for Williston does not describe the characteristic markings of the abdomen. It is probable that all his specimens (like his cotype) were poorly preserved. In a fresh condition the abdomen of the female is yellowish-red to blackish-brown, usually darker posteriorly, and bears a narrow and rather inconspicuous, longitudinal, median stripe of gray pruinosity, covered with a few yellowish hairs; the stripe widens slightly at the apical margins of the several segments, thus consisting of a series of elongate lozenges; it is, moreover, readily rubbed off. The median stripe is not visible in my males. In my series of females the length varies from 10 to 15 mm. The males measure 11 to 12.5 mm. At Chichen Itzá I noticed that specimens taken toward the end of June were larger than those flying earlier in the month. After carefully comparing Williston's descriptions, I have reached the same conclusion as Hine, regarding the identity of *T. filiolus* and *T. hæmagogus.* Hine seems to have seen cotypes of both.

T. hæmagogus seems to be peculiar to Yucatan, where it is the most abundant horse-fly in summer, but appears later than the

other three common species. It flies at any time of day, from dawn until sunset, and is even on the wing during rain showers. It readily attacks domestic animals and also bites man. The few males I have taken were resting on leaves at the edges of the woods, early in the morning. In life the eyes of both sexes are uniformly bright green, without bands, and in the male they consist entirely of small facets.

Williston's record of *T. filiolus* from "Antilles, Cuba" was evidently based on the suggested identity of his species with *Tabanus rufiventris* Macquart (1838, 'Dipt. Exot.,' I, 1, p. 141; ♂), described from Cuba (not *T. rufiventris* Fabricius, 1805, nor of Macquart, 1846). The Cuban species is, however, very different and has been fully described by Hine as *T. bifloccus*. Kertész' (1908) record of *T. filiolus* from Jamaica was based upon a similar confusion. So far as known at present, *T. hæmagogus* has not been taken outside Yucatan.

Tabanus littoreus Hine

Tabanus littoreus Hine, 1907, Ohio Naturalist, VIII, p. 227 (♀; Puerto Barrios, Guatemala). Surcouf, 1921, 'Gen. Insect., Taban.,' p. 73. J. Bequaert, 1925, '13th Rept. United Fruit Co., Med. Dept.,' (1924), p. 206 (♀ ♂).

Colonia Santa Maria (near Puerto Morelos), in the northern part of the Territory of Quintana Roo, three females, May 13 to 22, 1929 (G. C. Shattuck).

I have also taken male and female of this species at Puerto Cortez, Rep. Honduras, March 18, 1924, and a female at Puerto Barrios, Guatemala, May 9, 1931, always near electric lights in the evening. It is readily recognized by the unusually broad frons, the shiny black, square frontal callosity, the appendix at the fork of the third longitudinal vein, and the prettily spotted abdomen. In life the eye is dark purple, with two broad, bright green cross-bands (Fig. 1*b*). The male is similar to the female, but the abdominal spots are less distinct; the eye in life is mostly bright green, with two narrow dark purple cross-bands in the lower third (Fig. 1*c*); this lower third, of the usual small facets, is sharply divided from the upper two-thirds, where the facets are much larger.

Tabanus campechianus Townsend

Tabanus campechianus C. H. T. Townsend, 1897, Canad. Entom., XXIX, p. 197 (♀; between Campeche and Esperanza, State of Campeche). Aldrich, 1905, 'Cat. North Amer. Dipt.,' p. 202. Kertész, 1908, 'Cat. Dipt.,' III, p. 232. Surcouf, 1921, 'Gen. Insect., Taban.,' p. 63.

This species is known only from the type specimen. I have failed to recognize it among the many tabanids collected in Yucatan, although it quite likely occurs there. It is small (8.5 mm.), with very broad, parallel-sided frons (about one-sixth the width of the head, and only a little more than twice as long as wide); lower frontal callosity brown, nearly square, a smaller longitudinal callosity above it; thorax with four somewhat indistinct, wide, brownish stripes; abdomen brownish-yellow. with three yellowish-white pollinose stripes; the median stripe well-defined and of even width, the lateral stripes not so distinct and broken up; wings fuscous-hyaline; the costal cells and stigma distinctly yellow; no appendix. It belongs apparently to the group of *Tabanus lineola* Fabricius, which contains many closely allied species in North and Central America. Several of those described from Mexico have never been properly recognized.

The very broad frons places this species near *T. littoreus,* from which it appears to be quite distinct, as shown in my key, where I quote part of the original description *verbatim.*

Tabanus yucatanus Townsend

Tabanus yucatanus C. H. T. Townsend, 1897, Canad. Entom., XXIX, p. 198 (♀; cenote of Xcolak, 10 miles southeast of Izamal, Yucatan); 1897, Trans. Texas Ac. Sci., II, 1, p. 49. Aldrich, 1905, 'Cat. North Amer. Dipt.,' p. 209. Kertész, 1908, 'Cat. Dipt.,' III, p. 293. Surcouf, 1921, 'Gen. Insect., Taban.,' p. 89.

Chichen Itzá, State of Yucatan, many females and two males; common throughout June, 1929. Merida, State of Yucatan, one female, July 6, 1929. Colonia Santa Maria (near Puerto Morelos), in the northern part of the Territory of Quintana Roo, May, 1929 (G. C. Shattuck).

In life, the eye of the female is dark purple to coppery purple with two bright green cross-bands, of which the upper one is rather ill-defined at the inner corner (Fig. 1*d*).

T. yucatanus belongs in the group of trivittate species. The three pale dorsal bands of the abdomen are not continuous: the median one consists of narrow elongate triangles, the apex of which barely reaches the anterior margin of each tergite; the lateral ones comprise slightly oblique spots which reach both the anterior and posterior margins. Fore legs black, the basal third of the tibiæ pale reddish with white hairs; the middle and hind legs pale reddish, with black tarsi; antennæ reddish-brown, with black apical style. Frons slightly narrowed below, about six times as long as wide at the subcallus; the basal callosity elongate-elliptical or subrectangular, barely connected with the very narrow, short median callosity, which extends to the upper third. Length, 9 to 12 mm. It averages smaller than *T. maya*, has a relatively narrower frons, with different callosities, and the antennæ are of a different shape (third segment shorter, less crescent-shaped, with the upper projecting angle much smaller). In perfectly fresh specimens there is a small median area covered with black hairs at the anterior margin of the scutellum.

Male (undescribed).—Extremely similar to the female, with which it is easily associated. The third antennal segment is more slender. The abdominal markings are similar, but somewhat less marked. Eye divided into two areas of unequal extent, the upper area the larger, of enlarged facets; the lower area with the usual small facets; in life dark purple, slightly greenish in the upper area which is separated by a bright green line from the lower area, the latter also with a wide, green cross-band (Fig. 1*e*).

Length, 10 mm.

Allotype and male paratype from Chichen Itzá (Mus. Comp. Zoöl., Cambridge, Mass.).

T. yucatanus is known thus far only from the northern part of the Peninsula of Yucatan, where it is a common fly. It bites horses and mules very readily and will occasionally attack man. The males were observed in the early morning, hovering in clearings of the dry bush, some ten feet above the ground.

The remains of the female and male specimens from Honduras (San Nicolas; San Lorenzo; Sa. Cruz), referred by Szilády (1926, Biologica Hungarica, I, 7, p. 23, Pl. IV, fig. 14) to *T.*

yucatanus, have been sent to me recently by Dr. W. Horn. These specimens were certainly wrongly identified, as is clear even from the figures and from the author's statement that the gray lateral spots of the abdomen were oblique, oval, not reaching the border of the segment. The frons of the female is a little over four times as long as wide at the subcallus (according to my measurements; Szilády's figure shows it too narrow). The markings of the thorax of the male are not by any means as conspicuous as Szilády figures them. The antenna, as drawn by Szilády (now broken off in all specimens), is different from that of *T. yucatanus* and *T. maya*, though more like the former. So far as I can judge from the remaining débris, these specimens of Honduras differ from all named Mexican and Central American species in my collection, as well as from any of the published descriptions. I have, however, two unnamed females from the Colima Volcano, Mexico, which appear to be the same species.

Tabanus maya, new species

A medium-sized, black and reddish-brown species; the abdomen with three longitudinal rows of grayish spots forming continuous, irregular stripes; legs black and reddish-brown, basal half of fore tibiae white; palpi white; antennae reddish-brown; wings subhyaline.

Female.—Length, 11 to 14 mm.; width of head, 4 to 5 mm.; length of wing, 9 to 11.5 mm.

Head black; the ground-color entirely hidden by a pollinosity which is grayish-white on the face and occiput, yellowish on the subcallus and frons; the short, erect hairs of the frons black; the pile of the face longer and white; the jowls with very long, silvery-white pile. Frons (Fig. 2) a little over four times as long as wide at the subcallus, slightly narrowed below; basal callosity black, elongate-rectangular, narrowly separated from the eyes, squarely truncate above; median callosity black, linear, short, not

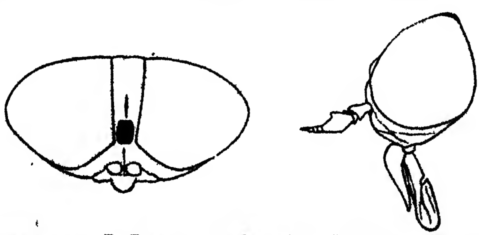

FIG. 2. *Tabanus maya* J. Bequaert, female. Head in front and side-view.

extending beyond the middle and (in fresh specimens) not connected with the basal callosity; vertex without trace of tubercle or bare spot in fresh specimens. Terminal segment of palpus distinctly swollen in the basal half, and rapidly narrowed into the pointed apex; white, with a few, very short, black hairs. Antenna short, bright reddish-brown, the narrow apical portion slightly darker brown; first segment moderately swollen short, with black pile; second segment small, the upper apex very long and slender, with black pile; third segment short crescent-shaped, the basal division much narrowed at the middle, with a prominent but broad and bluntly rounded upper edge. Eyes bare, in life purplish-black with three broad, bright green bands, which fuse before the occipital margin (Fig. 1*f*). Thorax black, covered with ash-gray pollinosity dorsally, more grayish-white ventrally; the pile of the dorsum sparse and short, mostly yellowish-white, mixed with a few black hairs, especially on the scutellum; on pleura and sternum the hairs are much longer and silvery-white; dorsum without traces of longitudinal stripes. Abdomen pale reddish-brown to mahogany-brown, the base infuscated behind the scutellum and hind coxæ; dorsally with three rows of yellowish pollinose spots forming irregular stripes; the median stripe is continuous and consists of a series of narrow truncated triangles, with curved sides; the two lateral stripes are wider, also continuous, but much more irregular, as each of them consists of a series of oblique spots which are broadly separated from the median stripe as well as from the sides; on the extreme sides the dorsum of the abdomen is margined with grayish-white; on the gray spots the short pile is yellowish-white, elsewhere it is black; venter entirely grayish-white pollinose, with short white hairs. Legs normal, without fringes, the fore tibiæ and tarsi slightly wider than those of the other legs; all coxæ with white pollinosity and long white hairs; fore legs black with short black pile, the basal half of the tibiæ bright white, with silvery-white hairs; middle and hind legs mostly yellowish-red and with yellowish white pile, the tarsi infuscated and with black hairs, the basal third to half of the femora black; outer side of the tibiæ with a mixture of short black hairs. Wing subhyaline, with a faint yellowish tinge, somewhat more apparent along the veins; stigma distinct, elongate, amber-yellow; fork of third longitudinal vein without appendix; all posterior cells open; squamæ subhyaline, the notch between them with a tuft of yellowish hairs; halteres yellow.

Female holotype (Mus. Comp. Zoöl., Cambridge, Mass.) and 20 female paratypes, Chichen Itzá, State of Yucatan, June 3 to 16, 1929 (J. Bequaert Collector). A few of these specimens were trapped in a screened cage; some were caught while flying back and forth along trails. None were observed biting.

T. maya belongs in the difficult group of trivittate species, of which some 20 to 30 have been described from the New World.

In view of the fact that several of these species have not yet been satisfactorily cleared up, I feel reluctant to add one more. I have compared *T. maya* with specimens of *T. yucatanus* Townsend, *T. lineola* Fabricius, *T. costalis* Wiedemann, *T. nigrovittatus* Macquart, *T. quinquevittatus* Wiedemann, *T. acutus* Bigot, *T. fuscicostatus* Hine, *T. appendiculatus* Hine, *T. carneus* Bellardi, *T. littoreus* Hine, *T. trilineatus* Latreille, *T. vittiger* Thomson, *T. trivittatus* Fabricius, *T. stenocephalus* Hine, *T. modestus* Wiedemann, *T. plangens* Walker, and *T. cineparius* Wiedemann. From all of these *T. maya* can easily be separated. The majority of these species have the median stripe of the abdomen quite regular and parallel-sided; some differ in having a shiny denuded subcallus, a very broad or very narrow frons, differently shaped antennæ, or the hind femora either wholly black or entirely yellowish-red. I have indicated in the key the characters by means of which the four species of this group, known from Yucatan, may be told apart.

Tabanus itzarum, new species

A small black species, with the dorsum of the thorax and most of the second and fourth tergites and sternites covered with golden-yellow or white, appressed hairs; legs and palpi black; antennæ reddish-brown; wings hyaline.

Female.—Length, 9 to 11 mm.; width of head, 3 to 3.8 mm.; length of wing, 7.5 to 9.5 mm.

Head black, the middle of the face and the subcallus reddish-brown, entirely covered with dark ashy-gray pollinosity; the short erect hairs of frons and face black; the jowls clothed with long, soft pile, mostly pale yellowish. Frons (Fig. 3) a little over five times as long as wide, parallel-

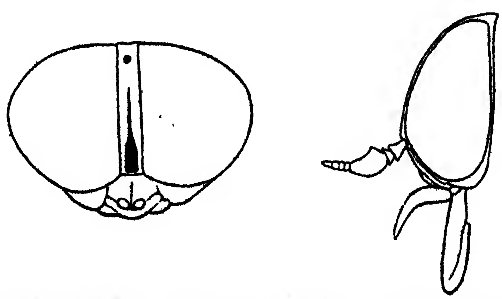

FIG. 3. *Tabanus itzarum* J. Bequaert, female. Head in front and side-view.

sided throughout; basal callosity reddish-brown to black, elongate, gradually narrowed above into a linear, black, median callosity which fades away between the middle and the upper third of the frons; vertex with a small, low, median ocellar tubercle, surrounded by a circular depression; the rudimentary anterior ocellus barely indicated. Terminal segment of palpus moderately slender, very gradually swollen toward the base; black and covered with short, black, appressed pile. Antennæ short, bright reddish-brown, the narrow apical portion slightly infuscated; first segment not swollen, short, with black pile; second segment small, moderately produced at the upper apex, with black pile; third segment short crescent-shaped, the basal division broad throughout, distinctly angular above, but without tooth. Eyes bare, in life uniformly purplish-black. Thorax black, grayish pollinose; the dorsum and scutellum densely covered with short, appressed, bright golden-yellow or pure white pile, the sides with longer, erect, yellow or white hairs, which form a conspicuous tuft beneath the base of the wing. Abdomen pale reddish-brown to black, often darker toward the tip, moderately shiny; typically most of the second and fourth segments, both ventrally and dorsally, are covered with short, appressed, golden-yellow to whitish pile; on the second tergite there is much admixture of short black hairs, which, in some specimens, may cover most of the surface; sometimes there is also an admixture of black hairs on the fourth tergite; the remaining segments with short black hairs, but the sides of the first often with much yellowish pile. Legs normal, black, with short black hair; tibiæ not swollen, without fringes; fore tarsi not dilated. Wings hyaline, very slightly yellowish along the costa; stigma distinct, elongate, amber-yellow; fork of third longitudinal vein without appendix; all posterior cells open; squamæ infuscate, the notch between them with a tuft of yellowish hairs; halteres reddish-brown.

Female holotype (Mus. Comp. Zoöl., Cambridge, Mass.) and 75 female paratypes, Chichen Itzá, State of Yucatan, June 4 to 30, 1929 (J. Bequaert Collector). One female paratype, Merida, State of Yucatan, July 2, 1929 (J. Bequaert Collector). One female paratype, southeast of Peto, near the border of the Territory of Quintana Roo, June 1929 (G. C. Shattuck Collector). Some of the specimens were trapped in a large screened cage; others were taken in the bush, especially toward dusk, when this species darts back and forth in open clearings or along trails. I have never observed it biting man.

T. itzarum is clearly related to *T. leucaspis* Wiedemann and other similarly colored species for which Kröber uses the generic term *Leucotabanus*. In 1929 (Zool. Anzeiger, LXXXIII, pp.

58–63), Kröber included in the same group *T. albicans* Macquart (1846) and *T. pallidus* (Kröber); while more recently (1930, Zool. Anzeiger, LXXXVI, pp. 260–261) he added *T. albidocinctus* Bigot, *T. arvensis* Brèthes, and *T. unicinctus* Walker. All of these species are readily distinguished from *T. itzarum, inter alia,* by the partly white or yellowish tibiæ.

Like many other generic names introduced by Ad. Lutz, *Leucotabanus* is somewhat of a nomenclatorial puzzle. So far as I have been able to trace it, Ad. Lutz and A. Neiva first used it, in connection with the name of a described species, in 1914 (Mem. Inst. Osw. Cruz, VI, p. 71), when they included "*Leucotabanus leucaspis* Wied." in an enumeration of tabanids collected in the State of Rio de Janeiro. A year before (1913, Brazil Medico, No. 45, December 1st, p. 6 of reprint), Ad. Lutz had characterized the genus, but without mentioning a species. I am, therefore, of the opinion that *Tabanus leucaspis* Wiedemann (1828) should be regarded as the type of *Leucotabanus.*

The status of *Pseudacanthocera* Ad. Lutz is analogous to that of *Leucotabanus.* Proposed in 1913 with a description, but without mention of a species, the name was used in 1914 by Ad. Lutz and A. Neiva for "*Pseudacanthocera marginata* (Macq.) = *sylveirii* (Macq.)." Its type is therefore *Silvius sylveirii* Macquart (1838), as correctly stated by Enderlein.

Enderlein (1925, Mitt. Zool. Mus. Berlin, XI, 2, p. 350) regards *Leucotabanus* Ad. Lutz and *Pseudocanthocera* Ad. Lutz as identical with *Pseudoselasoma* Brèthes (1910, An. Mus. Nac. Buenos Aires, XX, p. 475), of which he designated, in 1922, *Pseudoselasoma opacum* Brèthes (1910) as the genotype. I lack the necessary material to discuss this synonymy, which I assume provisionally to be correct. Moreover, I am unable to regard *Pseudoselasoma* (= *Leucotabanus*) as a valid genus; it is at most a subgenus of *Tabanus.* In none of the species I have seen are the ocelli distinctly developed. In most specimens of *T. leucaspis* there is only the slightest trace of an anterior ocellus, while I have seen no examples with even rudimentary posterior ocelli.

Enderlein includes in *Pseudoselasoma* only the following species: *P. opacum* Brèthes, *P. nitidum* Brèthes, *P. sylveirii* (Macquart), *P. leucaspis* (Wiedemann), *P. brevicorne* Ender-

lein, and *P. bicinctum* Enderlein. All of these species are from South America and differ from *T. itzarum* in having the tibiae partly pale-colored.

Tabanus leucaspis Wiedemann

Tabanus leucaspis Wiedemann, 1828, 'Aussereurop. Zweifl. Ins.,' I, p. 179 (♀; Brazil). J. Bequaert, 1926, 'Med. Rept. Hamilton Rice 7th Exp. Amazon,' p. 229.

Leucotabanus leucaspis Kröber, 1929, Zoolog. Anzeiger, LXXXIII, p. 59 (♀; ?♂).

Tabanus cingulifer Walker, 1857, Trans. Ent. Soc. London, N. S., IV, 5, p. 123 (♀; Amazon Region, Brazil).

Tabanus albiscutellatus Macquart, 1850, Mém. Soc. Sci. Lille, (1849), p. 342, Pl. II, fig. 9; 1850, 'Dipt. Exot.,' Suppl. IV, p. 34, Pl. II, fig. 9 (♀; Mexico). Osten Sacken, 1878, Smithson. Miscell. Coll., No. 270, p. 60.

Chichen Itzá, State of Yucatan, two females, June 24 and 26, 1929. One was taken by sweeping the net through the air in a clearing of the bush where it was darting back and forth. It made no attempt to bite. The second specimen was resting on the trunk of a tree, some eight feet above the ground. In life the eyes are uniformly dark purplish-black.

The specimens from Yucatan agree with the female from Rio Branco, Amazonas, which I have called *T. leucaspis* in 1926; with a female from Paraguay named *leucaspis* by Bezzi; and with two females from southern Brazil received as *leucaspis* from Ad. Lutz. I have seen the same species from British Honduras (Benque Viejo), Columbia (Rio Frio), British Guiana, and Peru (Putumayo District). All these specimens have the third antennal segment not toothed nor crescent-shaped, but provided near the base with a small, sharp dorsal projection; the palpi are blackish and the sides of the thoracic dorsum as well as the scutellum are conspicuously white-haired. In size they range from 11 to 13 mm. Wiedemann mentions the black palpi and the pale yellowish sides of the notum in the original description; his specimen was about 11 mm. (4¾ lines) long. I do not believe, therefore, that I have misunderstood this species, as Kröber infers in a recent paper (1929).

Moreover, Kröber's new description of the female of *T. leucaspis* tallies with my specimens. Whether or not his male was correctly identified is impossible to tell, although the large size (15 mm.) makes it somewhat improbable. At any rate, Kröber is not quite correct in his statement that *Tabanus albiscutellatus* Macquart is the *male* of *T. leucaspis,* since Macquart's description was based upon the *female.* Nevertheless, Macquart's *albiscutellatus* was most likely *T. leucaspis* Wiedemann, since the original description mentions the black palpi and the "small tooth" of the antennæ. At the Museum of Comparative Zoölogy, there is a female from Mexico named "*albiscutellatus* Macquart" by Osten Sacken, which is identical with *T. leucaspis* Wiedemann.

What Hine (1925, Occ. Pap. Mus. Zool. Univ. Michigan, No. 162, p. 34) and I (1926, 'Medical Rept. Hamilton Rice 7th Exp. Amazon,' p. 230) have called *T. albiscutellatus,* is a very different insect. It is larger (15 to 16 mm.), with dirty yellowish-white palpi, black antennæ, and the third antennal segment strongly crescent-shaped; the dorsum of the thorax is more uniformly white all over than in *T. leucaspis.* It does not agree with Kröber's descriptions of *T. albicans* Macquart and *T. pallidus* (Kröber), both of which have the antennæ extensively yellowish or reddish and the third antennal segment not strongly crescent-shaped. It may, however, be *T. unicinctus* Walker, which has at least the first two antennal segments black. I have this supposed *T. unicinctus* from the Republic of Honduras and British Guiana. It would seem to me that *T. albicans* Macquart, *T. albidocinctus* Bigot, and *T. pallidus* (Kröber) are one and the same species.

Diachlorus ferrugatus (Fabricius)

Chrysops ferrugatus Fabricius, 1805, 'Syst. Antliat.,' p. 111 (Carolina).

Tabanus ferrugatus Wiedemann, 1821, 'Dipt. Exotica,' I, p. 94 (♀); 1828, 'Aussereurop. Zweifl. Ins.,' I, p. 186 (♀).

Dichelacera ferrugata Walker, 1848, 'List Dipt. Brit. Mus.,' I, p. 191; 1854, *loc. cit.,* V, Suppl. 1, p. 148.

Diabasis ferrugata Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., II, p. 396 (♀).

Diachlorus ferrugatus Osten Sacken, 1876, Mem. Boston Soc. Nat., II, p. 475; 1878, Smithson. Miscell. Coll., No. 270, p. 55; 1886, 'Biol. Centr.-Amer.,' Dipt., I, p. 57. Williston, 1901, *loc. cit.*, I, p. 263. Hunter, 1901, Trans. Amer. Ent. Soc., XXVII, p. 138. Ricardo, 1904, Ann. Mag. Nat. Hist., (7) XIV, pp. 358 and 359. N. Banks, 1904, Ent. News, XV, p. 290. Aldrich, 1905, 'Cat. North Amer. Dipt.,' p. 199. Ad. Lutz, 1907, Centralbl. Bakt. Paras., Abt. 1, Orig., XLIV, p. 142. Kertész, 1908, 'Cat. Dipt.,' III, p. 211. Surcouf, 1921, 'Gen. Insect., Taban.,' p. 51. J. Bequaert, 1925, '13th Rept. United Fruit Co., Med. Dept.,' (1924), p. 205. Root, 1925, *loc. cit.*, p. 208.

Tabanus americanus Palisot de Beauvois, 1813–1820, 'Insectes Rec. en Afrique et Amérique,' p. 222, Pl. III, Dipt., fig. 6 (♀; United States). Not *T. americanus* Forster, 1771.

Diabasis atænia Macquart, 1838, 'Dipt. Exot.,' I, 1, p. 152 (no sex; in part: specimen from Carolina). Walker, 1854, 'List Dipt. Brit. Mus.,' V, Suppl. 1, p. 271.

Chrysops convergens Walker, 1848, 'List Dipt. Brit. Mus.,' I, p. 198 (♀; Honduras); 1854, *loc. cit.*, V, Suppl. 1, p. 284.

Chrysops approximans Walker, 1848, 'List Dipt. Brit. Mus.,' I, p. 198 (no sex; Florida).

Tabanus rondanii Bellardi, 1859, 'Saggio Ditter. Messic.,' I, p. 68, Pl. II, fig. 11 (♀; Mexico).

Progreso, State of Yucatan (U. S. Nat. Mus.).

I have also seen this species from North Carolina, Alabama, Louisiana, the State of Tabasco (Frontera), British Honduras (Belize River; Benque Viejo), Guatemala, and the Republic of Honduras. There is no reliable record from south of Honduras nor anywhere in the West Indies. Statements as to its supposed occurrence in Brazil are based upon Macquart's confusing two distinct species under his *Diabasis atænia*, as shown by Ad. Lutz (1913, Mem. Inst. Osw. Cruz, V, p. 164). Macquart's Brazilian specimens were either *Diachlorus curvipes* (Fabricius) or *D. bivittatus* (Wiedemann). The distribution given by Surcouf (1921), *viz.*, "Iles Carolines, Brésil," is entirely erroneous.

The markings of the eye of the female in life are shown in Fig. 1*g*.

TEMPERATURE AS A FACTOR IN THE ACTIVITY AND DEVELOPMENT OF THE CHINESE STRAIN OF TIPHIA POPILLIAVORA (ROHW.) IN NEW JERSEY AND PENNSYLVANIA[1]

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INTRODUCTION

Success in the introduction of an insect parasite from one country to another for the purpose of biological control is dependent to a great extent on the interrelation of parasite and host, that is, the acceptance of the host by the parasite for oviposition and the ability of the parasite larvæ to develop and eventually produce normal adults. It is also dependent on the introduced parasite's adaptability to the new environment, and its ability to increase and disperse rapidly.

Tiphia popilliavora is at present recorded from Japan, Chosen (Korea), and China. Individuals from these three localities are taxonomically alike and have been grouped into one species, but owing to their biological differences it has been more practical to consider them as three separate strains.

The Japanese strain has been introduced, and is at present considered one of the promising parasites of the Japanese beetle (*Popillia japonica* Newman). During 1927 and 1928, 2,192 females of the Chinese strain were liberated in southern New Jersey and eastern Pennsylvania but as yet no recoveries have been made. The present paper reports a study of the Chinese strain made at Moorestown, New Jersey, during the fall of 1928 and 1929.

MATING

It was found that the females of this species would readily mate when closely confined. The container employed in mating

[1] Contribution No. 73. Japanese Beetle Laboratory, United States Department of Agriculture, Bureau of Entomology, Moorestown, New Jersey. The photographs are by R. L. Coffin, Bureau of Entomology, Moorestown, N. J.

females for liberation is a wooden box 7 inches by 11 inches by 5½ inches deep, the top of the box covered by a piece of plate glass sliding tightly in grooves. The box is provided with water, food, and soil. The water is put into 4-ounce bottles which are stoppered with cotton plugs covered with cheese cloth, and is fed to the stopper by means of a cotton lamp wick. The food is made of a mixture of honey and pulverized sugar, enough sugar being added to make a stiff dry candy. The food is packed into ½-ounce metal containers which are held upright in wooden blocks; four such containers are in each box, furnishing 2 ounces of food. One inch of moist sifted soil is placed in the bottom of the box. (Plate XXXXI, Fig. 1.)

The males are confined in the boxes until their death, but the females are removed after 48 hours and replaced by newly emerged individuals. One hundred males and fifty females are confined in each box.

Mating at Various Temperatures. In making observations of mating activities, three mating boxes were equipped with thermometers. One box was retained indoors; another was placed in a screen-covered insectary subject to outdoor temperatures and indirect light, and the third was placed out of doors exposed to direct light. Each box contained 50 females and 100 males.

The box indoors remained, with a slight variation, at about 70° F., and instances of copulation could be noted throughout the day. The activity of the Tiphia could be stopped at this temperature by darkening the box, but as soon as the insects were exposed to light they again became active. On one occasion the box was heated to 85° F., and at this temperature the activity increased so greatly that the main interest was to escape from confinement.

The boxes out of doors were observed from 8 a.m. to 3 p.m., during which time the air temperature within gradually rose from 55° to 75° F. As the temperature approached 66° the males emerged from the soil but they did not attempt flight until the air had warmed to from 65° to 70°. At 70° two females emerged, and by the time 75° was reached practically all the females had emerged and were in copula. There was apparently no difference in activity between those in the box in the indirect

light of the outdoor insectary and those in the box receiving the direct light.

OVIPOSITION

The mated females used in obtaining oviposition were chosen at random, while sorting the adults for liberation, and are representative of material used for colonization.

A 6-ounce tin, fitted with a shallow telescoping lid, was used to hold the soil and Popillia grubs to obtain the ovipositions. A metal partition divides the can into four compartments to prevent the grubs from injuring one another. The soil is firmly packed about the grubs to enable them to form cells, as it is almost impossible for Tiphia to attack and successfully oviposit on grubs in loose soil. Food for the parasites consisted of drops of a solution of 1 part of honey in 9 parts of water on small squares of paraffined paper which are placed upon the soil within the tins. (Plate XXXXI, Fig. 2.)

New host larvæ were dug and brought in from the field every other day, because grubs when stored in any great numbers during the fall are very susceptible to fungous and bacterial diseases.

Oviposition at a Constant Temperature. The oviposition record of 17 females is given in Table 1. This group was kept in the soil at a constant temperature of 68° F.

Oviposition at Variable Temperatures. A group of 35 females kept at a soil temperature of 70° F. for 24 hours deposited an average of 2.4 eggs each. When the temperature was lowered to 51.5° for 24 hours the average number of eggs deposited per female was 1.6, but the average at this temperature for an additional 24 hours was 0.6. When the temperature was returned to 70° the average oviposition for 24 hours was 2.6 per female.

A second group of ten females was divided into two lots which were kept at soil temperatures ranging from 50° to 75° F. The temperatures were obtained from thermometers inserted in a can of soil and kept under the same conditions as the cans containing the host and parasite. This experiment was run for 14 days after the first recovery of field-emerging Tiphia. From Table 2 it may be seen that between 50° and 60° F. there is almost no activity. The mean soil temperature from October 7 to 21, 1928, inclusive, was taken at a depth of 3 inches, as at this depth the

TABLE 1.—Number of days of life of Tiphia wasp and record of eggs laid at a soil temperature of 68° F., during October, 1928, at Moorestown, N. J.

Tiphia No.	Number of eggs laid on specified number of days after emergence																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	0	3	2	1	2	2	2	1	0	3	3	0	4	4	2	4	2	2	2	3	4	3	2	3
2	2	1	1	1	3	2	2	0	1	1	1	2	2	2	4	3	2	2	4	4	2	3		
3	2	1	2	2	4																			
4	0	1	2	1	4	2	1	1	4	2	0	3	3	2	4	2	3	4	2	2	3	1		
5	1	2	2	1	3	4	1	1	2	2	0	3	4	3	3	3	1	2	3	3	3	2	2	1
6	3	0	1	1	3	3	1	1	2	2	0	3	4	3	2									
7	0	1	3	2	1	0	1	1	1	3	1	2	3	2	1	3	2							
8	0	3	1	2	0	2	1	0	4	4	0	0												
9	2	1	1	0	0	1	2	1	1	1														
10	1	1	1	0	1	1	4	0	4	1	3	4	2	2	4	1	2	4	3	1	3	1	2	2
11	0	3	2	3	1	2	1	1	4	4	3	3	3	1	2	1								
12	0	1	2	1	0	2	2	1	4	2	2	3	1	2	4	3	2	4	3	3	3	1	3	1
13	2	2	2	1	0	3	2	1	0	4	4	4	3	3	4	4	2	3	3	3	3	4	1	
14	0	2	1	0	0	2	2	0	3	4	3	4	2	1	3	3	1	2	3	2	2			
15	1	2	3	0	0																			
16	0	2	1	2	0	3	3	2	3	4	4	3	2	3	4	4	4	3	3	4	2	3	3	4
17	1	1	1	2	0	0	1	0	2	3	2	2	2	2	2	2	2	3	2	3	2	2	1	1

Maximum number of eggs from one female	100
Maximum number of days lived	45
Minimum number of eggs from one female	6
Minimum number of days lived	5

TABLE 1.—*Continued*

Tiphia No.	Number of eggs laid on specified number of days after emergence																					Total	
	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	Days	Eggs
1	3	1	2	2	2	2																30	66
2																						23	48
3																						5	11
4																						22	47
5	2	3	1	1	2	2	2	3	2	1	3	1	1									37	76
6																						15	29
7																						17	27
8																						12	17
9																						10	10
10	2	2	1	2	2	2	1	2	2	2	2											35	68
11																						16	34
12	1	3	1	3	2	2	2	1														32	65
13																						23	58
14																						21	40
15																						5	6
16	1	2	4	2	3	3	3	2	1	2	3	0	2	1	1	2	1	1	0	0	0	45	100
17	1	2	2	1	4	1	2	2	1	2	1	2										39	63
																						387	765

Total eggs obtained	765
Average number of eggs from one female	45
Daily average eggs per female	1.98
Average length of life	22.77 days

TABLE 2.—*The Effect of Temperature on Oviposition Under Controlled Conditions with a Comparison of Existing Soil Temperatures in the Field, at Moorestown, N. J.*

1929	Mean soil temperature in the field	1st Lot		2nd Lot	
		Mean soil temperature in the tins	Average ovipositions per female	Mean soil temperature in the tins	Average ovipositions per female
	°F.	°F.		°F.	
Oct. 8	60.0	75.0	1.4	56.0	0.0
Oct. 9	57.5	75.0	1.8	62.5	0.0
Oct. 10	56.0	69.0	0.6	50.5	0.0
Oct. 11	55.0	50.0	0.0	70.0	0.2
Oct. 12	54.0	50.0	0.0	70.0	0.2
Oct. 13	56.0	50.0	0.0	68.0	0.0
Oct. 14	59.0	72.5	1.2	71.0	0.2
Oct. 15	58.2	72.5	1.6	72.5	0.7
Oct. 16	57.5	72.5	2.0	72.5	1.7
Oct. 17	57.5	55.0	0.0	72.5	1.0
Oct. 18	54.2	55.0	0.2	73.5	0.7
Oct. 19	50.7	72.5	2.2	73.5	1.5
Oct. 20	51.0	72.5	1.0	72.0	1.7
Oct. 21	52.5	72.5	1.2	73.0	2.0

greatest number of grubs will be found at this time. The mean soil temperature at this depth for the month of October was 55.2° F.

Unmated Females. Five unmated females were placed with grubs in soil immediately after emergence. As a check, five mated females were kept under the same conditions and at the same time with the unmated lot. The unmated females oviposited 110 times and the mated females 100 times. The soil was kept at a room temperature of approximately 70° F.

Rearing of Parasitic Larvæ

The grubs bearing parasite eggs were packed in soil in cross-section trays. Each compartment permits the grub to be surrounded by 2 cubic inches of soil. The tray has 196 sections in all, but only 144 are used for rearing purposes; the outer rows of compartments are subject to rapid drying and are filled with soil only. A few grains of wheat are placed in each section as

food for the host, for unless this is done the grub will move out quite frequently, sometimes completely leaving the tray. (Plate XXXXI, Figs. 3 and 4.)

Rearing at Room Temperatures. Fifty-two per cent of the Tiphia grubs issuing from parasitized Popillia grubs reared in soil at a room temperature of about 70° F. formed cocoons.

Rearing at Open Insectary Temperatures. Seven hundred and sixty parasitized grubs were reared in an outdoor insectary, at temperatures given in Table 3, which shows the maximum, minimum, and average for five-day intervals from September 11 to October 30, 1929, inclusive.

TABLE 3.—*Air Temperatures for the Period from September 11 to October 30, 1920, at Moorestown, N. J.*

1928	Maximum	Minimum	Mean
	°F.	°F.	°F.
Sept. 11–15	83.7	64.6	74.1
Sept. 16–20	74.1	60.0	67.0
Sept. 21–25	72.7	50.5	61.6
Sept. 26–30	59.6	44.5	52.0
Oct. 1–5	67.8	46.2	57.0
Oct. 6–10	60.3	51.0	55.6
Oct. 11–15	77.7	50.0	63.8
Oct. 16–20	78.4	59.4	68.9
Oct. 21–25	70.8	46.5	58.6
Oct. 26–30	55.7	35.4	45.5

When reared at these temperatures 4.3 per cent of the resulting Tiphia grubs formed cocoons. Only two cocoons were formed from ovipositions obtained after the first 10 days.

Rearing Under Natural Conditions. Beetle larvæ bearing 1,900 parasite eggs were "planted" in a sodded plot out of doors. The ovipositions had been obtained from September 16 to October 30, 1928. The grubs were placed individually in holes 1 inch in diameter, at a depth of 2 inches beneath the surface. The holes were packed firmly with soil and the plug of sod replaced.

The plot was completely dug over from October 25 to November 12, in 1929, and a total of 14 cocoons were recovered, all of

which were found 14 inches or more below the surface. No cocoons were developed from ovipositions placed in the field after October 2. The mean soil temperatures in October during the period of development of the parasite egg and larva were 58.6° F. at 3 inches, 59.8° at 6 inches, and 59.7° at 9 inches.

Rearing the Eggs of Unmated Females. The parasitic larvæ resulting from ovipositions by unmated females were reared at room temperatures, and the parasitic larvæ from the mated females were used as a check and reared under the same conditions and at the same time.

The progeny from the unmated females developed and formed 51 cocoons from 93 eggs, or 54.8 per cent. Only 42 per cent of the parasites from fertilized eggs formed cocoons.

Time of Emergence

Adults from the imported cocoons of this strain were more erratic in the time of emergence than any of the imported species reared under the same conditions. The peak of the emergence occurred the second year of storage and extended over a period of three months.

The field plot in which the parasitized grubs were "planted" in 1928 was observed the following season in order to check on the time of emergence under natural conditions. In September two cocoons were dug up which contained well formed pupæ. On October 7 a male was found burrowing from the soil. During the next three days two more males were taken while they were hovering over the grass. This time of the year is practically the same as recorded for emergence in China. An examination of the cocoons dug from the plot showed that nine adults had emerged, two cocoons contained dead adults, and one cocoon a live larva in apparently good condition. Two cocoons were perforated with numerous small holes which gave the appearance of having been made by mites. There was no evidence of what the cocoons might have contained, nor was there any evidence of adult emergence.

Though only a few cocoons were recovered, the indications are that the emergence occurs early in October and that there is a predominating tendency to a one-year cycle, whereas insec-

tary-reared material was more indicative of a two-year cycle with emergence in September, October, and November.

SUMMARY

The optimum temperatures for mating of the Chinese strain of *Tiphia popilliavora* (Rohw.) were observed to be between 65° and 75° F. The average length of life for adults was 22.77 days when kept at a constant temperature of 68° F. With the emergence occurring the second week in October, only 10 of the 22 days of life would be at all favorable for mating.

The soil temperatures in October do not inhibit oviposition, but will hold this activity at a minimum. The average mean soil temperature at 3 inches during October from 1924 to 1929 was 55.2° F.

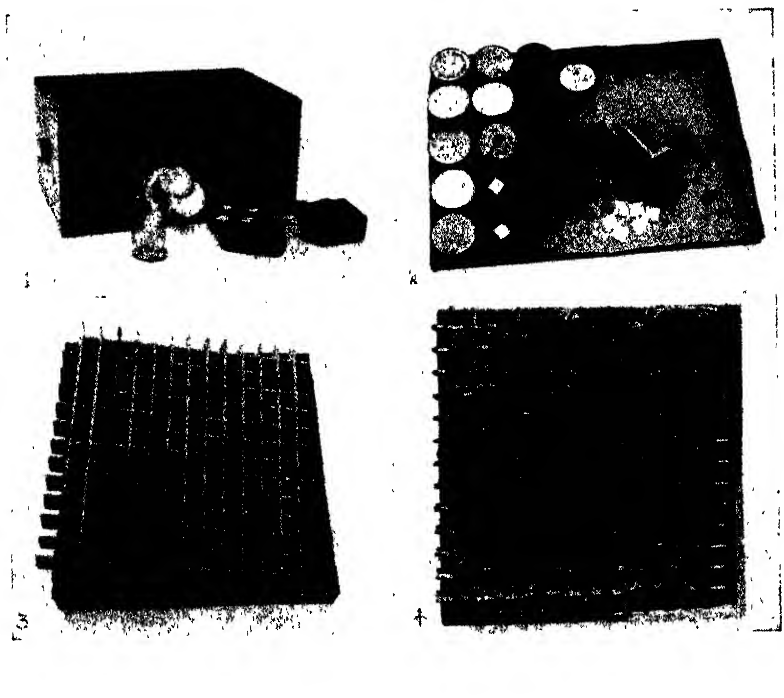
Temperatures below 60° F. are very unfavorable for the development of the parasitic larvæ and for cocoon formation. The mean soil temperatures during the developmental period are 59.8° F. at 6 inches and 59.7° F. at 9 inches.

CONCLUSION

The records obtained of the fecundity, the development of the parasitic larva on the host, and the percentage of adult emergence would indicate that the Chinese strain of *Tiphia popilliavora* may become a factor in the control of the Japanese beetle in infestations occurring south of New Jersey and Pennsylvania, but in the present latitude of heavy beetle infestation the existing climatic conditions at and after the time of emergence are not favorable for adult activity, or for the development of eggs and parasitic larvæ.

PLATE XXXXI

Figure 1. Mating box with equipment removed.
Figure 2. Six-ounce tins used for obtaining ovipositions.
Figure 3. Cross-section tray used for rearing.
Figure 4. Cross-sections removed and inverted showing the formed cocoons.



EFFECT ON CERTAIN FRESH FRUITS OF FUMIGATION WITH ETHYLENE OXIDE TO DESTROY THE JAPANESE BEETLE[1]

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Abstract

Ethylene oxide is used at the rate of 2 pounds per 1,000 cubic feet for two hours at 75° F. destroyed adults and larvæ of the Japanese beetle, adult Colorado potato beetles, and adult Mexican bean beetles.

Ethylene oxide may be used as herein described without any appreciable damage to raspberries and blackberries, but is slightly injurious to blueberries and severely injures wet green bananas.

When used at the rate herein mentioned, ethylene oxide is injurious to the foliage of Azalea and Hydrangea.

Since the development of a method for fumigating fresh fruit with carbon disulphide[2] to destroy the adult Japanese beetle, experiments have been underway to develop a fumigant for this purpose which would be equally effective as an insecticide and as non-injurious to the fruit, but which in addition would be less inflammable and explosive than carbon disulphide. The preliminary experiments with different compounds indicated that ethylene oxide, a chemical whose insecticidal properties were discovered by Cotton and Roark[3] might be substituted for carbon disulphide for this purpose.

Cotton and Roark have shown that a dosage of 1 pound per 1,000 cubic feet of space for 20 hours proved to be 100 per cent

[1] Contribution No. 93 of the Japanese Beetle Laboratory, Bureau of Entomology, Moorestown, N. J.

The author wishes to acknowledge the assistance given by W. E. Fleming, Entomologist in Charge, Plant Disinfection Investigations, Bureau of Entomology, and R. B. Wilcox, Assistant Plant Pathologist, Bureau of Plant Industry, United States Department of Agriculture.

[2] Osburn, M. R. Fumigation of fresh fruit with carbon disulphide for the destruction of adult Japanese beetles, N. J. Dept. Agr. Circ. 188, 1930.

[3] Cotton, R. T., and Roark, R. C. Ethylene oxide as a fumigant. Ind. and Eng. Chem. 20: 805, Aug., 1928.

lethal to specimens of the webbing clothes moth, ***Tineola bisselliella*** Hum.; the black carpet beetle, *Attagenus piceus* Oliv., and the furniture carpet beetle, *Anthrenus vorax* Csy.; the rice weevil, *Sitophilus oryza* L.; the Indian meal moth, *Plodia interpunctella* Hbn.; the saw-toothed grain beetle, *Oryzæphilus surinamensis* L.; the red-legged ham beetle, *Necrobia rufipes* DeG.; and the confused flour beetle, *Tribolium confusum* Duv.

Ethylene oxide, according to Back, Cotton, and Ellington,[4] has been used as a fumigant with success in destroying infestations of the webbing clothes moth, the furniture carpet beetle, the confused flour beetle, the rice weevil, and the saw-toothed grain beetle.

PROPERTIES OF ETHYLENE OXIDE

The physical properties of ethylene oxide have been described recently by Back, Cotton and Ellington[5] and Roark and Nelson.[6] It is at ordinary temperatures a colorless gas; at low temperatures, it is a mobile colorless liquid boiling at 10.5° C. The specific gravity of liquid ethylene oxide is 0.887 at 7°/4° C. The empirical formula is C_2H_4O. The molecular weight is 44.031. The concentrated vapors of ethylene oxide are inflammable, but concentrations up to 3½ pounds per 1,000 cubic feet of space are non-explosive and non-inflammable. The ignition point is 814° F. Ethylene oxide has a faint but distinct ether-like odor and the vapor is approximately 1.7 times as heavy as air. The vapor exhibits remarkable penetration into such compact materials as soil. The vapor of ethylene oxide, while not highly toxic to man, should not be inhaled extensively.

EFFECTIVENESS OF ETHYLENE OXIDE AS A FUMIGANT

The effect of ethylene oxide as a fumigant for fresh fruit was determined in a fumigation house of 1,000 cubic feet capacity,

[4] Back, E. A., Cotton, R. T., and Ellington, G. W. Ethylene oxide as a fumigant for food and other commodities. Jour. Econ. Ent. 23: 226, Feb., 1930.

[5] Back, E. A., Cotton, R. T., and Ellington, G. W. Ethylene oxide as a fumigant for food and other commodities. Jour. Econ. Ent. 23: 226, Feb., 1930.

[6] Roark, R. C., and Nelson, O. A. Densities of mixtures of air and various fumigants. Jour. Econ. Ent. 23: 985–987, Dec., 1930.

10 feet long, 10 feet wide, and 10 feet high. It has a door in front and a window in the rear. It is gas-tight, being double walled throughout, with two-ply roofing paper between the walls, and lined on the inside with galvanized iron sheets, soldered together. The door and window are made tight by closing on metal strips. A hot-water heating system of 40 gallons' capacity, thermostatically controlled, was used to maintain the desired temperature. An electric fan, having its motor placed on the outside of the fumigation room, was used to circulate the vapor.

In the summer of 1930, some 16,000 adult Japanese beetles were fumigated, under varying conditions, with ethylene oxide to determine the best conditions for killing 100 per cent of them. In one series of tests, beetles were exposed directly to the vapor in rectangular cages 24 inches long, 11 inches wide, and 14 inches high. The sides and tops of these were covered with wire screen and each was provided with a door. In another series of tests, the beetles were treated while contained in baskets of fruit. Immediately before treatment, several boxes placed in various parts of each layer of a crate of fruit were artificially infested with beetles.

In connection with these experiments adults of the Colorado potato beetle (*Leptinotarsa decemlineata* Say) and the Mexican bean beetle (*Epilachna corrupta* Muls.), contained in rectangular wire-screen cages as described above, were exposed directly to the vapor of ethylene oxide, to determine conditions for killing 100 per cent. A comparison was made simultaneously of conditions necessary for killing 100 per cent of Japanese beetle larvæ exposed directly to the vapor of ethylene oxide in cross-section wire-screen cages, and for killing 100 per cent of Japanese beetle larvæ exposed to the gas when buried in the soil in 6-inch and 14-inch flowerpots.

In the various experiments, the insects were placed in the fumigation house as soon as the desired temperature was reached. In each experiment, the proper dosage of ethylene oxide was measured as a liquid and poured into shallow pans that rested on a table. The window and door of the house were closed and made tight. The fan was started to circulate the ethylene oxide

vapor, which evolves rapidly at ordinary fumigation temperatures. After the desired time had elapsed, the door and window were thrown open to ventilate the room. As soon afterwards as possible the treated insects, with the exception of Japanese beetle larvæ, were taken to the insectary, where they were examined, at the end of 24 and 48 hours, to determine the number that were alive or dead. The Japanese beetle larvæ were removed from the cages and soil immediately after treatment and placed on soil in wooden cross-sectioned trays. This procedure made it possible for any larvæ which had not been harmed by the treatment to go into the soil under normal conditions. At the end of five days all the larvæ were examined to determine the number dead or alive. For comparison, untreated insects were held in the same manner.

TEMPERATURE, EXPOSURE, DOSAGE

It was found that when adult Japanese beetles were exposed for two hours to the vapor of 1 pound of ethylene oxide to 1,000 cubic feet of space, 90 per cent of them were killed at a temperature of 65° F., 96 per cent at 70°, and 100 per cent at 75°. One pound for one hour killed 54 per cent at 75° and 93 per cent at 80°. When ethylene oxide was used at the rate of 2 pounds per 1,000 cubic feet 96 per cent of the beetles were destroyed at the end of one hour at a temperature of 75° and all of the beetles were destroyed when the temperature was raised to 80° or the period of exposure was prolonged to two hours.

Experiments in which beetles were fumigated in boxes of fresh fruit showed that it was necessary to use 2 pounds of ethylene oxide per 1,000 cubic feet of space for a period of two hours at 75° F. to obtain a 100 per cent mortality.

Potato beetles were more easily killed than adult Japanese beetles since a dosage of 1 pound per 1,000 cubic feet at 70° destroyed all the potato beetles in a period of two hours but killed only 96 per cent of the Japanese beetles.

Adult Mexican bean beetles were easier to kill than either potato beetles or Japanese beetles, for a dosage of 1 pound per 1,000 cubic feet at 60° for two hours destroyed 100 per cent, while higher temperatures were necessary for a complete kill of potato beetles and Japanese beetles.

Japanese beetle larvæ were not so easy to destroy as the adults since it was necessary to use 1 pound per 1,000 cubic feet for two hours at 75° to kill all the larvæ, while all Japanese beetle adults were destroyed at 70°.

Experiments with ethylene oxide as a soil fumigant to destroy Japanese beetle larvæ showed that when soil balls each 6 inches in diameter were treated at 80° F. a concentration of 2 pounds per 1,000 cubic feet for three hours destroyed all the larvæ buried in them, and 7½ pounds for two hours killed 100 per cent. Similar tests with soil balls of 14-inch diameter showed that all larvæ buried in them were destroyed when the balls were exposed to 10 pounds of ethylene oxide per 1,000 cubic feet at 80° for three hours.

A summary of the various tests is outlined in charts 1, 3, 4, 6, and 7.

THE EFFECT OF ETHYLENE OXIDE ON CERTAIN FRUITS

In the summer of 1930, raspberries, blackberries, and blueberries were fumigated with ethylene oxide at the rate of 2 pounds to 1,000 cubic feet of space for two hours at temperatures of 75° and 80° F., respectively. All fruits were treated immediately after they were received at the laboratory. The fruits thus used were as follows:

Fruits	*Variety*	*Quantity*
Blueberries	Rubel	32 quarts
Blueberries	Grover	32 quarts
Raspberries		936 pints
Blackberries		1,600 quarts
Bananas		30 hands

Upon completion of the treatment all of this fruit except the blueberries was taken from the fumigation chamber and held at outside temperatures together with a representative quantity of untreated fruit of the same varieties for at least 48 hours to determine the effect of the treatments. The blueberries were sent to R. B. Wilcox, Assistant Plant Pathologist, Toms River, New Jersey, who determined the effect of the treatment according to a system devised by the Bureau of Plant Industry, U. S. Department of Agriculture, in which the berries were placed in an incubator at 86° F. for a period of six days and then the

condition of the treated fruit was compared with that of the untreated. Raspberries and blackberries were apparently uninjured by the treatment, while the treated blueberries were slightly inferior to the untreated. A comparison based on the firmness of the raspberries and blackberries treated with ethylene oxide and the firmness of those untreated is shown in chart 2. The results with blueberries are shown in chart 5.

EFFECT OF ETHYLENE OXIDE ON WET BANANAS

Conditions at the port of Philadelphia make it necessary to fumigate railway fruit cars containing wet, green bananas. In view of the possibility of using ethylene oxide as the fumigant for this work, wet green bananas were exposed to 2 pounds of ethylene oxide per 1,000 cubic feet of space at 75° F. for two hours.

It was found that this treatment caused such extensive damage to the fruit that it would not be advisable to use ethylene oxide as the fumigating material.

EFFECT OF ETHYLENE OXIDE ON GROWING PLANTS

As preliminary experiments, two varieties of *Azalea indica*, *viz.*, Mme. Vandercruyssen and Mme. Petrick, and one variety of *Hydrangea opuloides*, namely, Mme. Chautard, were exposed to the vapor of 2 pounds of ethylene oxide per 1,000 cubic feet for two hours at 75° F. The plants were severely injured by the treatment, and the foliage turned black, curled, and fell in a few days.

PLATE XXXXII

Chart 1. Fumigation of Japanese beetle larvæ exposed directly to the vapor of ethylene oxide. Dosages were for 1,000 cubic feet.

Chart 2. Proportions of fruits that were firm after treatment with 2 pounds of ethylene oxide per 1,000 cubic feet for two hours at 75 and 80 degrees Fahrenheit, compared with the proportions of untreated fruits that were firm.

Chart 3. Fumigation of potato beetles with ethylene oxide for 2 hours. Dosages were for 1,000 cubic feet.

Chart 4. Fumigation of Mexican bean beetles with ethylene oxide. Dosages were for 1,000 cubic feet.

Chart 5. Blueberries that were treated with 2 pounds of ethylene oxide for two hours at 75 degrees Fahrenheit compared with untreated berries.

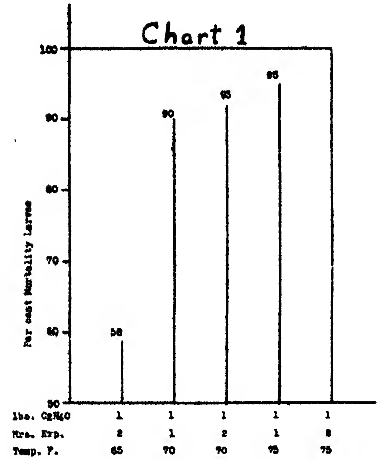
Chart 1
Per cent Mortality Larvae
100
90
80
70
60
50
58
90
93
95
lbs. C_2H_4O 1 1 1 1 1
Hrs. Exp. 2 1 2 1 2
Temp. F. 65 70 70 75 75

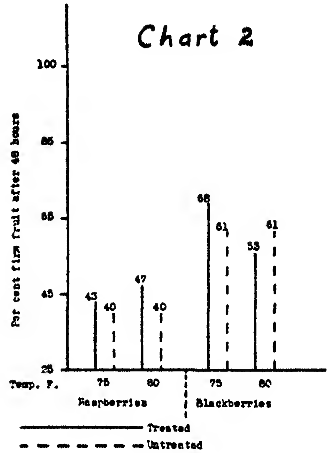
Chart 2
Per cent firm fruit after 48 hours
100
85
65
45
25
43
40
47
40
68
61
53
61
Temp. F. 75 80 75 80
Raspberries
Blackberries
Treated
Untreated

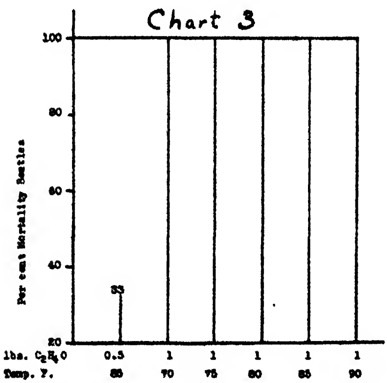
Chart 3
Per cent Mortality Beetles
100
80
60
40
20
33
lbs. C_2H_4O 0.5 1 1 1 1 1
Temp. F. 65 70 75 80 85 90

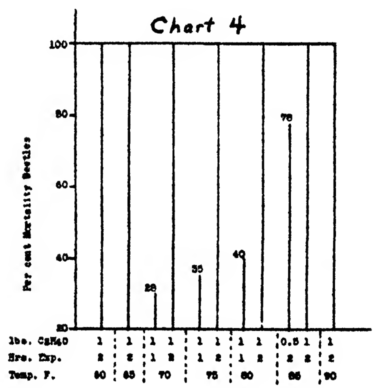
Chart 4
Per cent Mortality Beetles
100
80
60
40
20
28
35
40
78
lbs. C_2H_4O 1 1 1 1 1 1 1 1 0.5 1 1
Hrs. Exp. 2 2 1 2 1 2 1 2 2 2 2
Temp. F. 60 65 70 75 80 85 90

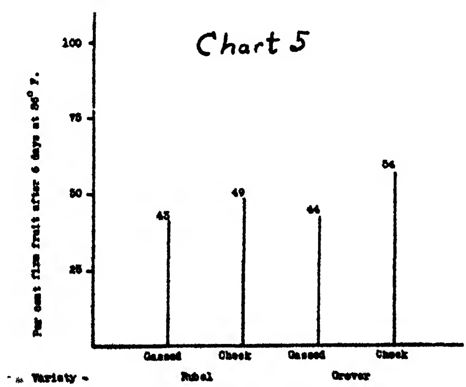
Chart 5
Per cent firm fruit after 6 days at 50° F.
100
75
50
25
43
49
44
54
Gassed
Check
Gassed
Check
Variety
Rubel
Grover

PLATE XXXXIII

Chart 6. Fumigation of adult Japanese beetles with ethylene oxide. Dosages were for 1,000 cubic feet.

Chart 7. Fumigation of soil containing Japanese beetle larvæ with ethylene oxide at 80° F. Dosages were for 1,000 cubic feet.

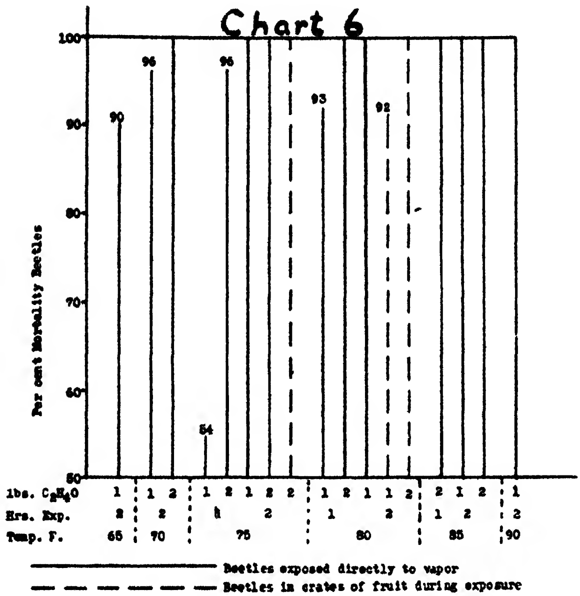
Chart 6
Per cent Mortality Beetles
100
90
80
70
60
50
90
96
96
54
93
92
lbs. C_2H_4O
Hrs. Exp.
Temp. F.
65
70
75
80
85
90
Beetles exposed directly to vapor
Beetles in crates of fruit during exposure

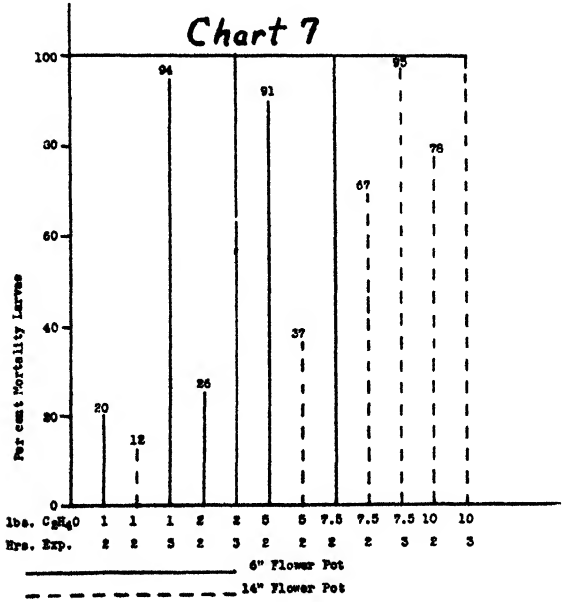
Chart 7
Per cent Mortality Larvae
100
80
60
40
20
0
20
12
94
26
91
37
67
95
78
lbs. C_2H_4O
Hrs. Exp.
6" Flower Pot
14" Flower Pot

A LIST OF THE SUGAR CANE INSECTS OF NEGROS OCCIDENTAL

BY W. DWIGHT PIERCE

The writer spent the period from August, 1927, to March 1, 1930, in Occidental Negros, P. I., in the employ of the Victorias Milling Co., and the North Negros Sugar Co., in the study of sugar cane insects. The results of these studies include the collection of a considerable collection of sugar cane insects, with many notes upon them. A large number of these species have now been determined by specialists, and it is possible therefore to list the more important enemies of the sugar-cane, and many of the parasites. By listing these at this time sugar-cane entomologists will be able to use the information without having to wait upon full reports.

Through the interchange of planting stocks the sugar-cane pests of Negros have been largely derived from Java, India, and other parts of the Orient.

I have presented the list in the tabular form in order to bring together the species responsible for the various types of injury, and also the determined enemies of each.

SUGAR CANE INSECTS OF OCCIDENTAL NEGROS, P. I.

Nature of damage	Name of insect	Enemies
Root grubs "buc-an" Very destructive	*Leucopholis irrorata* Chevrolat	*Campsomeris reticulata* Cameron *Campsomeris aureicollis* Lepeletier *Tyroglyphus* sp. *Rhizoglyphus* sp. *Isaria* sp. (fungus) *Cordyceps* sp. (fungus)
	Anomala anoguttata Burmeister	Probably *Campsomeris annulata* Fabricius
	Anomala humeralis Burmeister	*Campsomeris annulata* Fabricius *Campsomeris marginella modesta* Smith
	Autoserica nigrarubra Brancsik	
	Holotrichia mindanaona Brancsik	
	Lepidiota pruinosa Burmeister	
	All of above	The crow, *Corone philippina* Bonaparte The lark, *Alauda wattersi* Swinhoe Probably the blind snake *Typhlops braminus* (Daudin) eats the eggs
Large root destroyers	A cicadid larva *Gryllotalpa africana* Pal. Beauv. *Thlibops* sp. (Cerambycid)?	
Root corroders	Collembola undetermined Lepismids undetermined Molluscs undetermined	
Root suckers: Bugs	*Macroscytus transversus* Burm.	

SUGAR CANE INSECTS OF OCCIDENTAL NEGROS, P. I.

Nature of damage	Name of insect	Enemies
Root suckers, cont.	*Stibaropus molginus* Schiödte	
Leaf hopper	*Oliarus impeditus* Muir	
Aphid	*Tetraneura lucifuga* Zehntner	
Mealy bug	*Trionymus sacchari* (Cockerell)	
Scale	*Antonina indica* Green	
Nematodes	*Cacorema radicicola*	
	Tylenchus similis	
Seed cane injuries	*Macrotermes gilvus* Hagen	*Odontoponera transversa* (F. Smith)
Termites	*Microcerotermes losbanosensis* Oshima	
	Coptotermes vastator Light	
Beetles primary	*Alyssonotum pauper* Burmeister	
	Eutochia lateralis Boheman	
Perhaps secondary	*Gonocephalum depressum* Fabricius	
	Gonocephalum adpressum Germar	
	Carpophilus dimidiatus Fabricius	
Ants nesting in stools	*Odontoponera transversa* (F. Smith)	
Some good	*Polyrhachis dives* F. Smith	
Some bad	*Camponotus maculatus taylori* Forel	Strepsipteron
	Monomorium pharaonis Linnaeus	
	Dolichoderus bituberculatus (Mayr)	
	Odontomachus haematodes Linnaeus	
	Solenopsis geminata rufa (Jerdon)	

SUGAR CANE INSECTS OF OCCIDENTAL NEGROS. P. I.

Nature of damage	Name of insect	Enemies
Miscellaneous stool inhabitants	*Oligomyrmex* n. sp. *Tapinoma melanocephalum* Fabricius Large centipedes Spiders	
Seedling cane injury	Slugs Dipterous leaf miner Flea beetle *Aphis sacchari* Zehntner *Aphis maidis* Fitch	
Young shoot injury Dead heart moth borers	*Olethreutes schistaceana* Snellen	*Trichogramma nana* Zehntner *Microbracon chilonis* (Viereck) *Chelonus albicinctus* Ashmead *Goniozus* sp. Tachinid species
	Diatraea infuscatella Snellen	*Phanurus beneficiens* Zehntner *Trichogramma nana* Zehntner *Trichogramma minutum* Riley *Microbracon chilonis* (Viereck) *Apanteles flavipes* Cameron *Goniozus* sp. Tachinid sp.
	Both of above probably *Sesamia inferens* Walker and	*Anisolabis stali* Dohrn Egg parasite undetermined

SUGAR CANE INSECTS OF OCCIDENTAL NEGROS, P. I.

Nature of damage	Name of insect	Enemies
Moth borers, cont.	*Sesamia uniformis* Dudgeon	*Microbracon chilonis* (Viereck)
		Apanteles flavipes Cameron
		Ipobracon sp. perhaps *famulus* Bingham
		Xanthopimpla enderleini Krieger
		Kriegeria heptazonata Ashmead
	Siboga falsella Snellen	
	Diatraea venosata Walker	
	Amata deflocca Swinhoe	
	An Acronyctine n. sp.	
Beetles, fly-borer	An anthomyiid	
	Alyssonotum pauper Burmeister	
	Eutochia lateralis Boheman	
Dead heart scavengers, etc.	Aleocharinæ	
	Europs sp.	
	Hemipeplus sp.	
	Numerous flies as yet undetermined	
	Tyroglyphus sp.	
	Histiosoma sp.	
	Uropoda sp.	
	Parasitidæ (mites)	
	Collembola.	
Stalk injuries	*Topeutis intacta* Snellen	*Phanurus beneficiens* Zehntner
Moth borers	*Topeutis auriflua* Zeller and	*Eripternomorpha javensis* Rohwer

SUGAR CANE INSECTS OF OCCIDENTAL NEGROS, P. I.

Nature of damage	Name of insect	Enemies
Stalk injuries, cont.	*Topeutis* spp. cont.	*Elasmus zehntneri* Ferriere *Stenobracon trifasciatus* Szepligeti *Hormiopterus schoenobii* Rohwer *Aspergillus flavus* (fungus)
Moth borers, cont.	*Sesamia uniformis* Dudgeon	See above under dead heart
	Sesamia inferens Walker	
	Olethreutes schistaceana Snellen	See above under dead heart
	Diatraea venosata Walker	
	Diatraea infuscatella Snellen	See above under dead heart
Weevil	*Trochorhopalus strangulatus* Gyllenhal	Tachinid *Rattus concolor*
Shot hole borers	*Xyleborus perforans* Wollaston	
	Xyleborus near *luzonicus* Eggers	
Termite	*Coptotermes vastator* Light	
Node girdlers and bud worms	*Eutochia lateralis* Boheman	
	Opogona dimidiatella Zeller	
	Ereunitis sp.	
Suckers	*Trionymus sacchari* (Cockerell) is attended by *Dolichoderus bituberculatus* (Mayr)	Chalcid parasite
Mealy bug		*Haptonchus luteolus* Er. and *Carpophilus* sp. are associated *Aspergillus flavus* (fungus disease)
	Pseudococcus sp.	
Scale	*Aulacaspis tegalensis* (Zehntner)	Chalcid parasite

SUGAR CANE INSECTS OF OCCIDENTAL NEGROS, P. I.

Nature of damage	Name of insect	Enemies
	Aulacaspis, cont.	Coccinellid predators
Leaf injury	*Aphis sacchari* Zehntner attended by *Polyrhachis dives* F. Smith and *Solenopsis geminata rufa* (Jerdon)	
Juice suckers Aphids	*Aphis maidis* Fitch	Chalcid parasite
	Oregma lanigera Zehntner attended by *Polyrhachis dives* F. Smith *Dolichoderus bituberculatus* (Mayr) Juices attacked by *Capnodium* fungus	*Micromus pusillus* Gerst. *Cryptoblabes* sp. *Synonycha grandis* Thunberg Syrphids Braconid parasite, several Coccinellids
Scales	*Chionaspis depressa* Zehntner	
	Icerya n. sp.	
	Icerya seychellarum Westwood (occasional visitor)	
White flies	*Neomaskellis bergii* Signoret attended by *Dolichoderus bituberculatus* (Mayr) *Polyrhachis dives* F. Smith	Chalcid parasite
	Aleurolobus barodensis Maskell	Chalcid parasite
	Aleyrodes lactea Zehntner	
Thrips	Several species undetermined	
Mite	*Paratetranychus exsiccator* Zehntner	
Leaf hoppers	*Perkinsiella vastatrix* Breddin per-	Three species of egg parasites

SUGAR CANE INSECTS OF OCCIDENTAL NEGROS, P. I.

Nature of damage	Name of insect	Enemies
Juice suckers, cont.	haps inoculates red rot *Colletotrichum falcatum*	Dryinid *Paederus fuscipes* Curtis Predatory bug
	Proutista moesta Westwood inoculates *Cercospora* leaf spot	
	Lophops carinatus Kirby	Egg parasites
	Ricania tæniata Stål	
	Ricania proxima Melsheimer	
	Tettigoniella spectra Distant	Strepsipteron
Leaf eaters: miners in blade	*Cosmopteryx pallifasciella* Sn.	Parasite
	Monochirus callicanthus Bates,	
Miners in midrib	*Cosmopteryx dulcivora* Meyrick	Parasite
Chewers: Grasshoppers	*Atractomorpha psittacina* Haan	
	Euconocephalus nasutus Thunb.	
	Aeolopus tamulus Fabricius	
	Mecopoda elongata Linnaeus	
	Locusta migratoria Linnaeus	
	Phaneroptera furcifera	
Crickets	*Liogryllus bimaculata* DeGeer	
	Rhaphidophora deusta Brunner	
Lepidoptera	*Laelia suffusa* Walker	Tachinid
	Parnara nondoa Plotz	
	Parnara mathias Fabricius	Tachinid

SUGAR CANE INSECTS OF OCCIDENTAL NEGROS, P. I.

Nature of damage	Name of insect	Enemies
Leaf eaters, cont.	*Parnara*, cont.	*Bracon alguei* Ashmead
	Padraona nitida Mab.	Chalcid
	Melanitis leda Linnaeus	
	Mycalesis mineus Linnaeus	
	Marasmia trapezalis Guenee	*Apanteles* sp. with hyperparasite *Diaglypta prodeniae* Ashmead
	Spodoptera mauritia Boisduval	
	Laphygma exempta Walker	*Apanteles antipoda* Ashmead
		Microplitis manilae Ashmead
	Undetermined leaf feeder	*Apanteles taragamae* Viereck
	Utetheisa pulchella Linnaeus lays eggs on cane but feeds on *Heliotropium indicum*	
	Pyrausta nubilalis Hübner twice taken ovipositing on cane	
Miscellaneous Lepidoptera caught on cane	*Zinckenia fascialis* Cr.	
	Craspedia actuaria Walker	
	Calogramma festiva Donov.	
	Dinara combusta Moore	
	Crambus malacellus Dup.	
	Nymphula fluctuosalis Zeller	
	Pyrausta nubilalis Hübner twice	
	Eretmocera percnophanes Meyrick	

SUGAR CANE INSECTS OF OCCIDENTAL NEGROS, P. I.

Nature of damage	Name of insect	Enemies
Cane flower insects	*Balclutha* sp.	
	Macrosiphum near *granarium* Kirby	
	Europs sp.	
	Collembola	
	Geometrid	
Miscellaneous cane insects	*Proreus simulans* Stal	*Entomophthora forficulæ*
Predators	*Anisolabus ståli* Dohrn	
Roaches	*Mareta humbertiana* Saussure	Egg parasites
	Blattella near *germanica*	Egg parasites
Mantids	*Hierodula patellifera* Serv.	Egg parasites
	Statilia maculata Thunberg	
Wasps	*Ropalidia* sp.	Egg parasites
Fungus feeder	*Cecidomyiid* larva feeding on spores of *Uromyces kuhnii* Krueg., cause of cane rust	
Spiders	*Cyclosa melanura* Simon	
	Cyclosa insulana Costa	
	Thomisus laglaizii Simon	
	Heratemis chrysozona Simon	
	Tetragnatha hasselti Thor	
	Argiope aemula Walck	
	Ischnocolus insularis Simon	
	Plexippus paykulli A. & S.	

COCCOIDS COLLECTED ON WILD PLANTS IN SEMI-ARID REGIONS OF TEXAS AND MEXICO (HOMOPTERA)

BY F. F. BIBBY
AGRICULTURAL EXPERIMENT STATION, COLLEGE STATION, TEXAS

Below is a list of Coccoidea which were collected on wild plants in semi-arid regions of Texas and Mexico, mostly, however, in Hidalgo County of the Lower Rio Grande Valley of Texas. In every instance the locality (or localities) in which the coccoid was taken is listed, as is the host (or hosts).

The coccoids were collected in 1922, 1926, 1927, and 1928, and were identified by Dr. Harold Morrison, of Washington, D. C., unless otherwise noted. The hosts were identified by the late Professor H. Ness and Mr. V. L. Cory, both of the Texas Agricultural Experiment Station, by Dr. Paul C. Standley, of the U. S. National Museum, and by Dr. Frederick V. Coville, of the U. S. Department of Agriculture. The common names of the plants (placed in parentheses after the technical ones) were learned from obliging Mexicans in the interior of Mexico and along the Texas-Mexico border. In most instances these are the only names by which the plants, in their habitats, are known to the inhabitants.

The species are listed under their respective families, along with the hosts and localities, as follows:

ASTEROLECANIIDÆ

Lecaniodiaspis sp. on bark of *Populus* sp. (álamo) at Presidio, Presidio County, Texas.

Solenococcus sp. nearest to *artemisiæ* (Ckll.) on *Amyris parvifolia* A. Gray (barreta) and *Ricinella vaseyi* C. & F. at Mission, Hidalgo County, Texas.

DACTYLOPIIDÆ

Dactylopius tomentosus (Lam.) on *Opuntia* sp. at Mission, Hidalgo County, Texas.

PSEUDOCOCCIDÆ

Pseudococcus sp., or a closely related genus; quite possibly undescribed; on *Salix* sp. at Mission, Hidalgo County, Texas.[1]

LACCIFERIDÆ

Tachardiella mexicana (Comst.) on *Pithecolobium flexicaule* (Benth.) Coulter (ébano), *Pithecolobium brevifolium* Benth., *Acacia amentaceae* DC (chaparro prieto), *Acacia farnesiana* (Linn.) Willd. (huisache), and *Prosopis chilensis* (Molina) Stuntz (mezquite) at Mission, Hidalgo County, Texas.

COCCIDÆ

Ceroplastes cirripediformis Comst. on *Karwinskia humboltiana* Zucc. (coyotillo) at Mission, Hidalgo County, Texas.

Ceroplastes irregularis Ckll. on *Atriplex canescens* (Pursh.) James at a point locally known as Fossil Hill, between Alpine and Terlingua, Brewster County, Texas.

DIASPIDÆ

Aspidiotus coursetiæ Marl. on bark of *Celtis pallida* Torr. (granjeno), *Leucophyllum texanum* Benth. (cenizo), *Amyris parvifolia* A. Gray (barreta), *Xanthoxylum pterota* H. B. K. (colima), *Cercidium floridum* Benth. (retama or palo verde), *Karwinskia humboltiana* Zucc. (coyotillo), *Porliera angustifolia* (Engelm.) A. Gray (guayacán), *Pithecolobium brevifolium* Benth., and *Ricinella vaseyi* C. & F. at Mission, Hidalgo County, Texas, and on *Acacia* sp. (largoncillo) at Chihuahua, Chihuahua, Mexico.

Aspidiotus sp. very close to *coursetiæ* Marl. on *Salix* sp. and *Amyris parvifolia* A. Gray (barreta) at Mission, Hidalgo County, Texas.

Aspidiotus diffinis Newst. on leaves of *Porliera angustifolia* (Engelm.) A. Gray (guayacán) at Mission, Hidalgo County, Texas.

Aspidiotus herculeanus D. & H. on *Acacia farnesiana* (Linn.) Willd. (huisache) at Mission, Hidalgo County, Texas.

[1] Associated with this pseudococcid were two species of ants determined by Dr. W. M. Mann as *Pseudomyrma gracilis* var. *mexicana* Roger and *Cremastogaster lineolata* var. *clara* Mayr.

Aspidiotus juglans-regiæ Comst. on *Salix* sp. at Presidio, Presidio County, Texas.

Aspidiotus lataniæ Sign. on *Baccharis neglecta* Britton (jara china), *Condalia obovata* Hooker (abrojo), and *Prosopis chilensis* (Molina) Stuntz (mezquite), galls of, at Mission, Hidalgo County, Texas, and on *Cercidium floridum* Benth. (retama or palo verde) at Weslaco, Hidalgo County, Texas.

Aspidiotus subsimilis Ckll.[2] on bark of *Prosopis chilensis* (Molina) Stuntz (mezquite) at Tlahualilo, Durango, Mexico, and *Jatropha spathulata* (Ort.) Muell. (sangre de drago) at Mohovano, Durango, Mexico.

Chionaspis sp. that does not agree fully with any of our species, resembling European *C. salicis* (Linn.) more nearly than American *C. salicis-nigræ* (Walsh); also resembling *C. longiloba* Cooley in some respects and *C. corni* Cooley in others; on *Salix* sp. at Mission, Hidalgo County, Texas.

Chrysomphalus sp. closest to *apicatus* Newst. and *phenax* Ckll., not certainly identical with either, perhaps undescribed, on *Celtis pallida* Torr. (granjeno) at Mission, Hidalgo County, Texas.

Chrysomphalus sp. closest to *apicatus* Newst., quite possibly undescribed, on *Salix* sp. at Mission, Hidalgo County, Texas.

Chrysomphalus sp. close to *lilacinus* Ckll. on *Acacia berlianderi* Benth. at Mission, Hidalgo County, Texas.

Chrysomphalus sp. closely related to *perseæ* (Comst.) and *albopictus* (Ckll.) on leaves of *Pithecolobium flexicaule* (Benth.) Coulter (ébano) at Mission, Hidalgo County, Texas.

Chrysomphalus scutiformis (Ckll.) on leaves of *Porliera angustifolia* (Engelm.) A. Gray (guayacán), *Pithecolobium flexicaule* (Benth.) Coulter (ébano), and *Phaulothamnus spinescens* A. Gray (panalero or ojo de víbora) at Mission, Hidalgo County, Texas.

Chrysomphalus sp. on galls of *Prosopis chilensis* (Molina) Stuntz (mezquite) at Mission, Hidalgo County, Texas.

Diaspis echinocacti cacti Comst. on *Opuntia leptocaulis* DC. at Mission, Hidalgo County, Texas.

[2] Identified by Mr. G. B. Merrill of the Florida State Plant Board.

Diaspis texensis (Ckll.) on *Koeberlinia spinosa* Zucc. (junco) and *Castela nicholsoni* Hooker (amargosa), leaves of, at Mission, Hidalgo County, Texas.

Diaspis sp. near *townsendi* Ckll. on unidentified plant at Mission, Hidalgo County, Texas.

Pseudodiaspis yuccæ (Ckll.) on bark of *Acacia berlianderi* Benth. and *Acacia farnesiana* (Linn.) Willd. (huisache) at Mission, Hidalgo County, Texas.[3]

Lepidosaphes mimosarum (Ckll.) on *Prosopis chilensis* (Molia) Stuntz (mezquite), *Pithecolobium flexicaule* (Benth.) Coulter (ébano), and *Pithecolobium brevifolium* Benth. at Mission, Hidalgo County, Texas.

Lepidosaphes sp. close to *mimosarum* (Ckll.) on *Acacia* sp. probably *farnesiana* (Linn.) Willd. at Castolon, Brewster County, Texas.

Lepidosaphes sp. on *Atriplex canescens* (Pursh.) James at a point locally known as Fossil Hill, between Alpine and Terlingua, Brewster County, Texas.

Targionia yuccarum (Ckll.) on *Baccharis* sp. at Presidio, Presidio County, Texas.

Xerophilaspis prosopidis Ckll. on *Prosopis chilensis* (Molina) Stuntz (mezquite) at Castolon, Brewster County, Texas.

Pseudoparlatoria parlatoroides (Comst.) on *Porliera angustifolia* (Engelm.) A. Gray (guayacán), leaves of, and *Amyris parvifolia* A. Gray (barreta) at Mission, Hidalgo County, Texas.

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[3] On each of the hosts, this diaspid was being destroyed by an entomogenous fungus determined as *Sphaerostilbe coccophila* (Desm.) Tul. by Vera K. Charles of the U. S. Department of Agriculture.

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A WIRE BEETLE RECEPTACLE FOR JAPANESE BEETLE TRAPS

By Edgar G. Rex

New Jersey Department of Agriclture, Trenton

As a part of the Japanese beetle suppression activities of the New Jersey Department of Agriculture, observations concerning the operation of the mechanical trap have led to the introduction of a few changes in design, which appear to be well placed. The standard mechanical trap as developed by the Federal Japanese Beetle Laboratory at Moorestown, N. J., consists of a funnel with a surmounted baffle, the body or can, the bait receptacle, and a beetle receptacle (heretofore a pint or quart glass jar) affixed to the bottom of the can. The shortcomings of the glass jar beetle receptacle are:

1. Capacity usually restricted to a pint or quart.

2. Becomes fouled by beetle excretions and regurgitations, necessitating frequent washing.

3. Almost airtight condition results in generation of odors, damaging to the efficiency of the trap.

The idea of a wire mesh beetle receptacle to replace the glass jar was conceived while observing traps in operation during the summer of 1930 at Elmer, N. J. A local tinsmith was employed to construct several wire receptacles which were subsequently tried and found to be more practical than the glass jar. During the fall of 1930 a detachable rigid wire mesh receptacle, of three quart capacity was designed. Plate XXXXIV illustrates the wire receptacle as well as the mode of attachment to the bottom of the trap. A quarter turn of the receptacle is necessary for attachment and detachment. The wire beetle receptacle was given a thorough trial during the beetle season of 1931, and demonstrated quite convincingly the following advantages:

1. Capacity of 4 quarts may be attained without appreciable addition of weight. Capacity is important on days of heavy flight. Plate XXXXV shows trap filled to top of funnel with

beetles (about five quarts) captured from 10 A. M. to 2:30 P. M., July 12, 1931.

2. Cleaning or washing of receptacle is not necessary.

3. Aeration of the mass of captured beetles delays the appearance of decomposition odors several days after capture.

PLATE XXXXIV

Parts of trap showing the wire receptacle and the method of attaching it to the bottom of the trap.

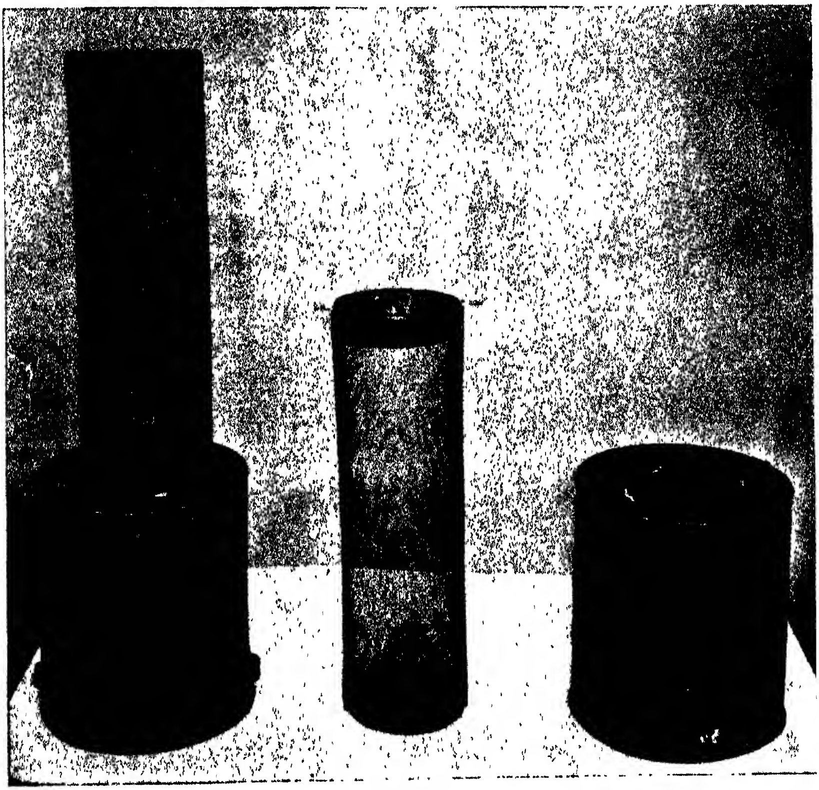
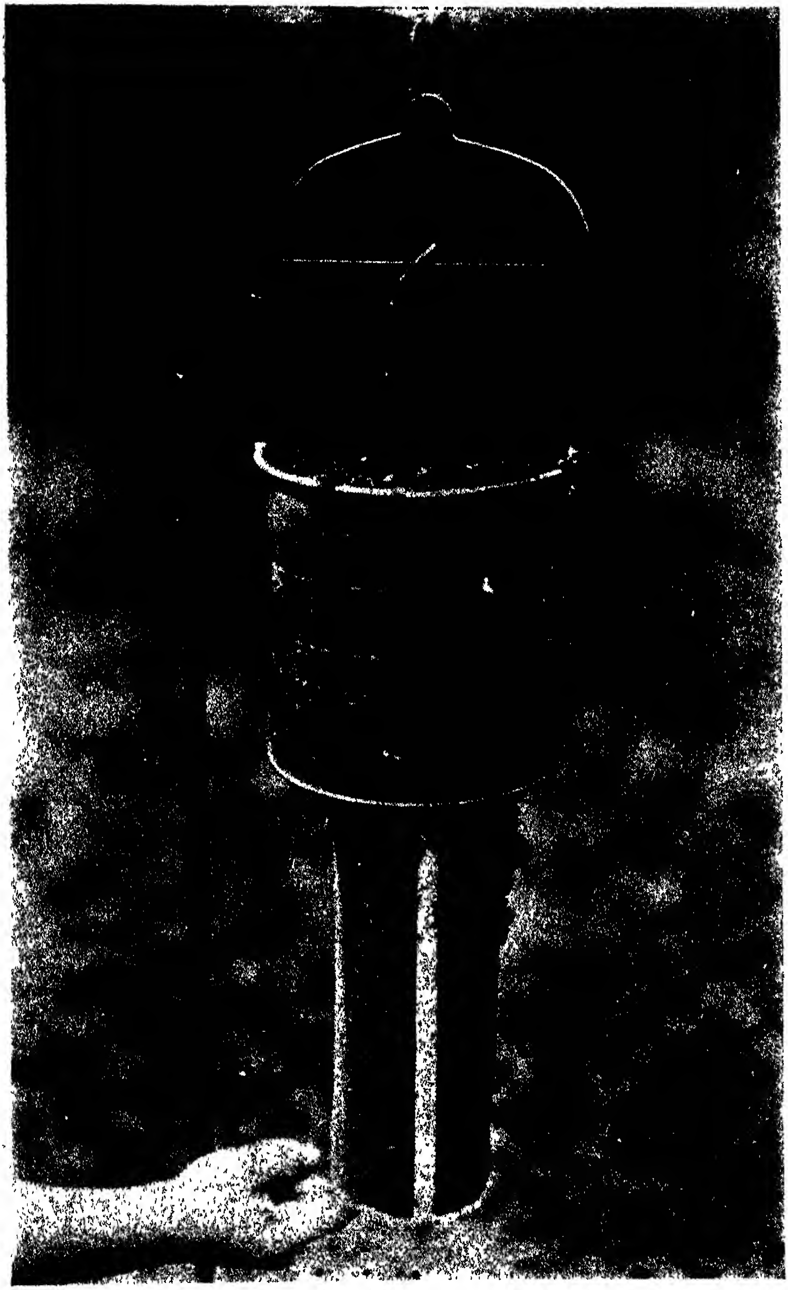


PLATE XXXXV

Trap filled to the top of the funnel with beetles



PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

MEETING OF FEBRUARY 17, 1931

A regular meeting of the New York Entomological Society was held at 8 o'clock on February 17, 1931 in the American Museum of Natural History with twenty members and eight visitors present. President Andrew Mutchler in the chair.

The minutes of the preceding meeting were read and approved.

Dr. W. S. Creighton, Charles Egri, and Dr. Alfred Weed, were unanimously elected members of the Society.

The secretary read a communication from Mrs. Mary R. Moetz and distributed lists of the collection of lepidopterous and coleopterous specimens of the late George F. L. Moetz which Mrs. Moetz is offering for sale.

Dr. Alfred Weed, of John Powell & Co., Inc., read a paper on "Pyrethrum as an Insecticide." He spoke of the confusion that had always existed in the cultivation and distribution of pyrethrum, because of the lack of standardization. At present the Federal Government recognizes three species, *Chrysantheum roseum, carneum,* and *Dalmatian.* The first cultivation or source for Pyrethrum known was in Persia. Pyrethrum was introduced into Europe in 1850; and soon after that became known in America. The superior flower, *Dalmatian*, grows at a 4,000 to 6,000 foot elevation and has a June blossom which is picked by hand. The third year of growth is the first market crop; the production is increased in the 5th, 6th, and 7th years until the 8th year when it begins to decrease.

The cultivation of it here in the Southern States has been hampered by wire worms and root rot fungi. Dr. Weed spoke of the extensive *roseum* cultivation in Japan which has been steadily increasing since 1881 when it was first introduced. At present Japan is supplying 70 per cent. of the entire pyrethrum crop of the world.

Dr. Weed described the work of Staudinger, McDonald and Rourke, Abbott and others on the toxicity of pyrethrum. It is due to two esters.

He said that pyrethrum had long been used as a household insecticide in combination with a wide variety of solvents, the most valuable of which is petroleum ether. The mist or vapor produced by spraying must be sufficient to reach the insect. Its agricultural use was limited.

Dr. Horsfall asked what types of biological tests had been used in pyrethrum experimentation.

Dr. Weed described the 6 ft. cubic chamber used for spraying flies. The tests are carried over a 6 month period.

Dr. Wilcoxan described the reaction of the flies to pyrethrum as being that of a violent combing of the abdomen, while other insecticides produce a stunned reaction.

Dr. Moore spoke on the possibility of oxidation removing the toxic influence. There is little known about this aspect of the subject.

Dr. Pierce questioned the value of the tests when the supply was so variable.

Mr. Curran said he had known pyrethrum in powdered form to be used as an insecticide on cabbage as it was non-poisonous to humans. He found that in using "Pine Oil," the flies died from lack of exercise, while in using pyrethrum, they died from too much exercise.

Mr. Safro spoke of the development of the pyrethrum industry in Japan as compared with the industry in the United States.

Mr. Wuster exhibited dwarf specimens of *Telea polyphemus* and *Samia cecropia*, and a black form of ♀ *Papilo glaucus*.

MEETING OF MARCH 3, 1931

A regular meeting of the New York Entomological Society was held on March 3, 1931 at 8 o'clock in the American Museum of Natural History. President Andrew Mutchler in the chair with twenty-one members and seventeen visitors present.

The minutes of the preceding meeting were approved as read.

The program committee announced the program for the next meeting.

The resignation of Mrs. B. Heineman was accepted with regret.

Mr. John D. Sherman, Jr., spoke at some length of the "European Wanderings of an Entomological Bookdealer" from March, 1930, until January, 1931, beginning very auspiciously at Cairo with a cordial reception by Efflatoun Bey, whose fine library and neatly mounted collection of Diptera were greatly admired. In Cairo, Mr. Sherman made his inital book purchase —a set of "Genera Insectorum." Mr. Sherman was interested in seeing, the Sharp collection of Dytiscidæ in the British Museum and the Zimmerman Collection of this family at Munich contained in forty-seven boxes, and now offered for sale by Mrs. Zimmerman for 15,000 marks. At Avignon, France, Dr. Guignot was visited. Dr. Guignot's dytiscids are beautifully mounted and he has had Fall's papers on the family as well as Tanner's thesis translated into French. Other entomological collections seen included the very fine collection of European and especially Italian Coleoptera owned by Dr. Luigione, of Rome, Dr. Verity's enormous collection of Palearctic butterflies with huge series showing variations, the Bezzi collection of Diptera purchased together with the Bezzi library by the Museum of Milan for 9,500 lira, the Corporaal collections of Cleridæ in Amsterdam (1,300 species). Mr. Corporaal besides his matchless collection of Cleridæ has nearly all of the literature on the family, part of it in the original form. The superb Lucassen collection of Cetoniidæ was visited. The famous Staudinger establishment in a large villa in the suburbs of Dresden was visited, where beautiful Agrias may be bought at 400 marks each, but also fine, male morphos as cheap as 4 marks.

Many well known entomologists were met on the Continent—Dr. Grandi at Bologna, Dr. Escherich at Munich, Dr. Handschin at Basle, Dr. Roepke at Wageningen, Dr. Schouteden at Tervueren, Mr. d'Orchymont at Brussels,

Dr. Seitz at Frankfort, and Dr. Csiki and the very lovable Dr. Horvath at Budapest. Mr. Sherman commented upon the respect and consideration accorded to the venerable directors of European museums, many of whom are entomologists. Dr. Gestro at Genoa is 85, Dr. Bolivar at Madrid is 80. Dr. Horvath now 85—has only recently retired.

Many wonderful libraries, both private and belonging to institutions were visited, the first one being the Vatican Library in Rome with 500,000 volumes, including 12,000 incunabula, and some 70,000 manuscripts, but practically no entomological books. An opportune visit was made to the Academia Lincei in Rome which has fine library of serials. Other fine libraries visited were those of the museum at Milan, the Museum of Natural Sciences at Madrid, the huge botanical library, including the De Candolle Library (and herbarium) at the Botanical Garden in Geneva, and the library of the Teyler Museum in Haarlem, also very rich in botanical works. The Drory Library of bee books in the Zoological Museum at Berlin was extremely large. In Bologna, Dr. Guercio exhibited the Berlese collection of 267 thick volumes of papers on the Acarina. In Florence, Dr. Verity had many choice and rare books on Lepidoptera, while in Munich Curt von Rosen's Library contained more rare entomological books perhaps than any other private library seen. In Munich, Mr. Taeuber is both an entomologist with a huge collection of Philippine Heteroptera and a dealer in rare old books, with a very fine private library. In Amsterdam Dr. Mac Gillavry, a very genial and hospitable entomologist—also a very busy surgeon—employs three young women to take care of his library; besides his bound books on all animals, he has a huge closet almost entirely filled with papers on Hemiptera which are being prepared for the binder.

Some of the rare books seen for the first time were the first (Folio) edition of Linne's "Systema Naturæ" 1735–1736, the 43 plates of Scopoli's "Entomologia Carniolica," the "Buch der Natur" by Conrad von Megenburg—the first book on natural history published in Germany (Augsburg, 1478), the "Lichtenstein Catalogues" of sales of insects held at Hamburg in 1796 and 1797. In both of these catalogues many new species are described.

The staff of the British Museum (of Natural History) was very cordial. Through the all powerful aid of the "Empire Marketing Board" greatly enlarged quarters have been provided for the insect collections.

The Rothamstead Experimental Station at Harpenden, where Dr. Imms is located, was founded in 1842 and is the oldest existing institution of its kind, the station at Storrs, Conn, being the next oldest.

A very delightful day was spent with Dr. Karl Jordan at the perfect Rothschild Museum at Tring.

Mr. Sherman visited the homes of the Entomological Society of London, and of the Linnean Society of London, which contains Linne's own Library, and herbarium.

In the various book stores, Mr. Sherman found that the very expensive works, including those with finely colored plates were much more in evidence than the standard books used by students. Botanical works were prevalent.

American publications were scarce even in England. On the Continent, purchases were usually made by first consulting a card index of the books in the various "magasins" of the bookstore, from which the books desired were brought to you at the main place of business.

The famous Nijhoff establishment was visited in The Hague. "Les Sapins," the beautiful home of Miss Wytsman, near Brussels, was visited.

An auction at Sotheby's in London was attended. The sales are conducted very informally, and in a manner very different from that of American book auctions.

A very warm welcome both in a business way and socially was extended to the Sherman family by the heads of the leading scientific book shops of Europe—Mr. Chaundy of Dulau & Co., the Wegs of Leipzig, Mr. Williams of Quaritch, Mr. Freymann of Hermann's, and Mr. Loewe of Friedlander's.

Extensive purchases were made, including the large Goeldi Library examined at Bern. There were some lucky "breaks" including several occasions where Mr. Sherman had first pick from catalogues newly printed or in the course of preparation. Some "new species" of book stores, which issue no catalogues, were mentioned quite casually (but not by name).

Several weeks were spent in Berlin, where Dr. Horn's cosy museum, with its very complete bibliographical files and library were constantly consulted and used in preparing Catalogue 31.

Mr. Fiedler spoke of his co-purchase of the famous Goeldi Library with Mr. Sherman. He also commented on Mr. Sherman's good fortune in his personal contact with so many foreign and well-known book dealers.

MEETING OF MARCH 17, 1931

A regular meeting of the New York Entomological Society was held on March 17, 1931, at 8:00 o'clock in the American Museum of Natural History. President Andrew Mutchler was in the chair with twenty-three members and five visitors present.

The minutes of the preceding meeting were approved as read.

The program committee reported the program for the next meeting, April 7.

Mrs. Dora Vredenburgh, of Freehold, New Jersey, was proposed for membership in the Society.

A communication from the Osborn Zoological Survey, which expects to spend three years in Peru and Bolivia, was read by Mr. Leng.

Dr. W. S. Creighton read a paper on "The Nesting Habits of the New World Ants belonging to the Genus Solenopsis." He spoke of the distinction between the crater type of nest which consists of a pile of excavated material containing no passages and the true mound nest in which the excavated material is constructed with passages and used for incubation of eggs and brood. The mound type is used where the warm season is short.

Dr. Creighton then discussed the worker caste in ants. The most primitive exhibit a condition of primary monomorphism. This is followed by the reduction of size of some of the workers resulting in a polymorphic worker caste. Dimorphism is the next condition found in which the workers of

medium size drop out. Finally a condition of secondary monomorphism is achieved in which only the smallest workers, which are much smaller than the queen, remain.

Dr. Creighton spoke of the correlation between the degree of polymorphism and the character of the nest of the New World Species of the genus Solenopsis. The most polymorphic (*geminata and saevissima*) build large mound nests. The feebly polymorphic species (*xyloni, gayi,* and *bondari*) construct craters or nests under stones or logs without making a mound of any sort. This is also true of the monomorphic species but here are found the twig dwellers, such as *altinodis* and *picta* and the true thief ants, which lead exclusively subterranean lives and prey upon the brood of the larger ants, which they parasitize. Dr. Creighton pointed out that the occurrence of the New World species could not be satisfactorily explained on the assumption of migration from one common center of distribution, since the most primitive species apparently occupy the center with the intermediate forms at the periphery and the highly specialized species scattered evenly over the whole area.

Dr. Pierce said that he had found all Solenopsis predatory.

Dr. Moore mentioned the damage done by Solenopsis to young *Citrus germani* in Brownsville, Texas.

Mr. Bromley spoke of his stay at Ohio State University, where he worked on Dr. Hine's collection. He wrote two papers on the Psyllidæ of Ohio as memorials to Dr. Hine. They are to be published in the Museum Bulletin and in the Annals of the Entomological Society of America.

Miss Sherman spoke on the lighter aspects of the Sherman's year in Europe. She mentioned Cairo, Valencia, Paris, and Budapest as being among the high spots.

MEETING OF APRIL 7, 1931

A regular meeting of the New York Entomological Society was held in the American Museum of Natural History at 8 o'clock on April 7, 1931, with President Andrew Mutchler in the chair. There were sixteen members and seven visitors present.

The minutes of the preceding meeting were approved as read.

Mr. Nicolay announced the proposed field trip to Greenwood Lake, New Jersey, on Sunday, April 26.

Miss Dora Vredenburgh was unanimously elected as a member of the Society.

Mr. Davis read a communication from Mr. Bell, our vice-president in Jamaica. Although 100 specimens of Coleoptera and 100 butterflies have been received by Mr. Mutchler and Mr. Watson, Mr. Bell writes that collecting is unsatisfactory except at sea-level.

Dr. Clyde C. Hamilton, of the New Jersey Agricultural Experiment Station in New Brunswick, N. J., read a paper on the "Control of the Orchid Weevil (*Diorymerellus lævimargo*)." He introduced Mr. Holmes, President of the Thomas Young Nurseries of Bound Brook, New Jersey, and also Mr. Henderson, the expert botanist of the Nurseries, with whom he had worked

on the orchid weevil. Dr. Hamilton spoke of the orchid industry as being a very specialized one. There are three methods of propagation: by offsets, by division of stems or pseudobulbs, and by the development of the new plant from seeds in a sterile culture of agar in test tubes.

The weevil, *Diorymerellus lævimargo*, in its larval form feeds on the three or four year old roots. The adult beetle does injury to the sheath, to the bud, and to the bloom, the most important of these being done to the roots by the grub. In August and September, Dr. Hamilton began experimenting with different insecticides for their effect on the peat and roots, and later for their effect on the beetle. Paradichlorobenzine was found to be safe to the plant and toxic to the beetle. Quantities of four grams are sprinkled on every plant to prevent infestation. One beetle is found now where before treatment one hundred were found.

Dr. Hamilton said that the beetles are abundant in summer and when the plants are being forced by high temperatures for the Christmas trade, etc.

Mr. Henderson spoke on the progress made in germinating seeds. He mentioned the work of the English hybridists, and said that so far, little work has been done on the physiology and cytology of the orchid. He commented on the demands of social functions which regulate the production of orchids.

Dr. W. D. Pierce spoke on his experiments and observations of temperature and humidity and other factors which go to make up the daily rhythm for all life. He finds that there is a death, sleep, activity, sleep, death cycle on every scale for the Biosphere, for the Atmosphere, for the Geosphere and for the Phytosphere. He spoke of the survey of Ellsworth Huntington in Italy and France on 3,700,000 deaths, as carrying out his conception of the daily rhythm. Dr. Pierce displayed charts and diagrams to explain his theories.

Meeting of April 21, 1931

A regular meeting of the New York Entomological Society was held on April 21, 1931 at 8:00 P. M. in the American Museum of Natural History. President Andrew Mutchler in the chair with twenty members and twelve visitors present.

The minutes of the preceding meeting were approved as read.

The treasurer, Mr. Hall presented a report for April 1, 1931, which was approved and placed on file.

Mr. Adolph Klein was proposed for membership.

Upon the motion of Mr. Curran, it was unanimously voted that the Society go on record as congratulating its fellow member Dr. William Morton Wheeler on the presentation of the Leidy Medal to him by the Academy of Natural Sciences of Philadelphia.

In the absence of Dr. Frank E. Lutz, Mr. Curran read Dr. Lutz's paper "Light as a Factor in Controlling the Start of the Daily Activity of a Wren and Stingless Bees." (Novitates No. 468). Dr. Lutz's observations at Barro Colorado, Canal Zone, resulted in the conclusion that the wren's singing was controlled to a small extent by the appearance of light. The

bees' activity, that is the first flight from the nest, indicated that the bees, like the wren were a combination clock and photometer.

Mr. Schwarz and Dr. Pierce discussed Dr. Lutz's paper.

Mr. Herbert F. Schwarz read a paper on "Nest Habits of the Diplopterous Wasp, *Polybia occidentalis*, sub-species *scutellaris* (White), as observed at Barro Colorado, Canal Zone." (Novitates No. 471). The nest containing approximately 280 cells was built by 130 individuals, no males, in about 5 days. A very apparent division of labor was observed. Together with the building material which is carried to the nest there is a considerable amount of liquid transported to the nest. After completion of the nest it was observed that excess liquid was ejected by the individuals. The cause of this activity is not fully understood. In rain storms both natural and artificial, the wasps take precaution to keep the nest dry. Mr. Schwarz also made extensive observations on the bringing of prey to the nest.

MEETING OF MAY 5, 1931

A regular meeting of the New York Entomological Society was held on May 5, 1931 at 8:00 P. M., in the American Museum of Natural History; President Andrew Mutchler in the chair with twenty-four members and fourteen visitors present.

The minutes of the preceding meeting were approved as read. A communication was read from Mr. Rivnay, who is going to Palestine.

Mr. Adolph Klein was unanimously elected to membership in the Society.

Mr. Bell read a communication from Miss Louise Noble stating that she was anxious to collect for entomologists in the vicinity of Hope, Arkansas.

A series of nineteen Articles appearing in "Entomological News" on "North American Institutions featuring Lepidoptera" by J. D. Gunder has been bound into a single volume by the author.

Dr. Charles L. Pollard related some of his experiences in British Guiana during the past winter. He arrived there during the height of the short rainy season, and found Lepidoptera rather scarce. Collecting at light proved entirely unproductive, but banana baits were rather successful in attracting Morphos, Caligos and some nymphalids. Two species of longicorn beetles and one elaterid beetle were also commonly found on baits. Dr. Pollard commented on the fact that certain species were exceedingly local in habitat apparently quite irrespective of the occurence of the food plant. Comparing the geographical position of British Guiana with the Lower Amazon region, he pointed out that the affinities of many of the Guiana butterflies were with those of Para, 800 miles further east.

An observation on the leaf-cutting ant indicated that the form with large mandibles engaged chiefly, if not entirely, in the operation of leaf cutting, while a smaller form carried away the pieces of leaf after they had been severed.

Various specimens were exhibited the most noteworthy being a Papilio mimic of Helionius, a saturnid which was found in certain woods only, and a Castnia.

Dr. Pollard's remarks were discussed by Dr. Pierce, Lutz, Weiss, Moore and Lacey.

Mr. Frank Johnson commented on Dr. Pollard's experiences and mentionod the beautiful Copioterius that Dr. Pollard had brought to him.

Mr. Bell spoke on his trip to Jamaica. The time of year was not conducive to good collecting. Hesperids were found in one area 20 ft. by 6 ft. along a gorge. He observed the interesting flight of moths in waves.

Mr. Curran reported an orange-tail and a skipper seen at Tuxedo, N. Y., in the middle of April.

Mr. Davis gave the following records: The first *Vanessa antiopa* butterfly was seen at St. George, Staten Island, March 21. *Anax junius* dragon flies had arrived on the island by April 13, and were also seen on April 17 and 18. On April 19, a cabbage butterfly was seen flying about at Watchogue and the Red Admiral butterfly that usually appears from hibernation later than *antiopa* was also seen on April 19. These dates would indicates a normal spring.

ADDENDA

[Page 301, Vol. XXXIX. Insert before **Gargarini**; inadvertently omitted]

Coccosterphini

Key to Genera

1(6). Apex of clavus acute; posterior process broad at base, robust, dorsum waved or sinuate with an apical node.

2(3). Pronotum covered with tubercles; tegmina not longer than the abdomen .... †**Coccosterphus** Stal; **Phærotus** Buckton

3(2). Pronotum smooth, not tuberculate; posterior process not reaching apex of clavus or of abdomen; tegmina far surpassing apex of abdomen.

4(5). Pronotum gibbous, not compressed; tegmina with four apical cells .... †**Parayasa** Distant

5(4). Pronotum elevated and compressed, strongly convexly ampliated anteriorly and posteriorly; tegmina with five apical cells.. †**Insitor** Distant

6(1). Apex of clavus obtuse; dorsal line of pronotum straight; tegmina longer than abdomen.

7(8). Posterior process broad at base, acuminate, passing apex of clavus; metopidium depressed and strongly sloping posteriorly; tegmina with two discoidal and five apical cells........ †**Kanada** Distant

8(7). Posterior process slender, much shorter than clavus and abdomen; metopidium convex; apical angles of mesonotum not spined; tegmina with two discoidal and four apical cells, apical margin oblique, apical angle acute .... †**Yasa** Distant

INDEX TO NAMES OF INSECTS AND PLANTS IN VOLUME XXXIX

Generic names begin with capital letters. New genera, subgenera, species, subspecies, varieties and new names are printed in italics.

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